Sugar: A New and Profitable Industry in the United States for Agriculture, Capital and Labor, to Supply the Home Market with $100,000,000 of its Product.

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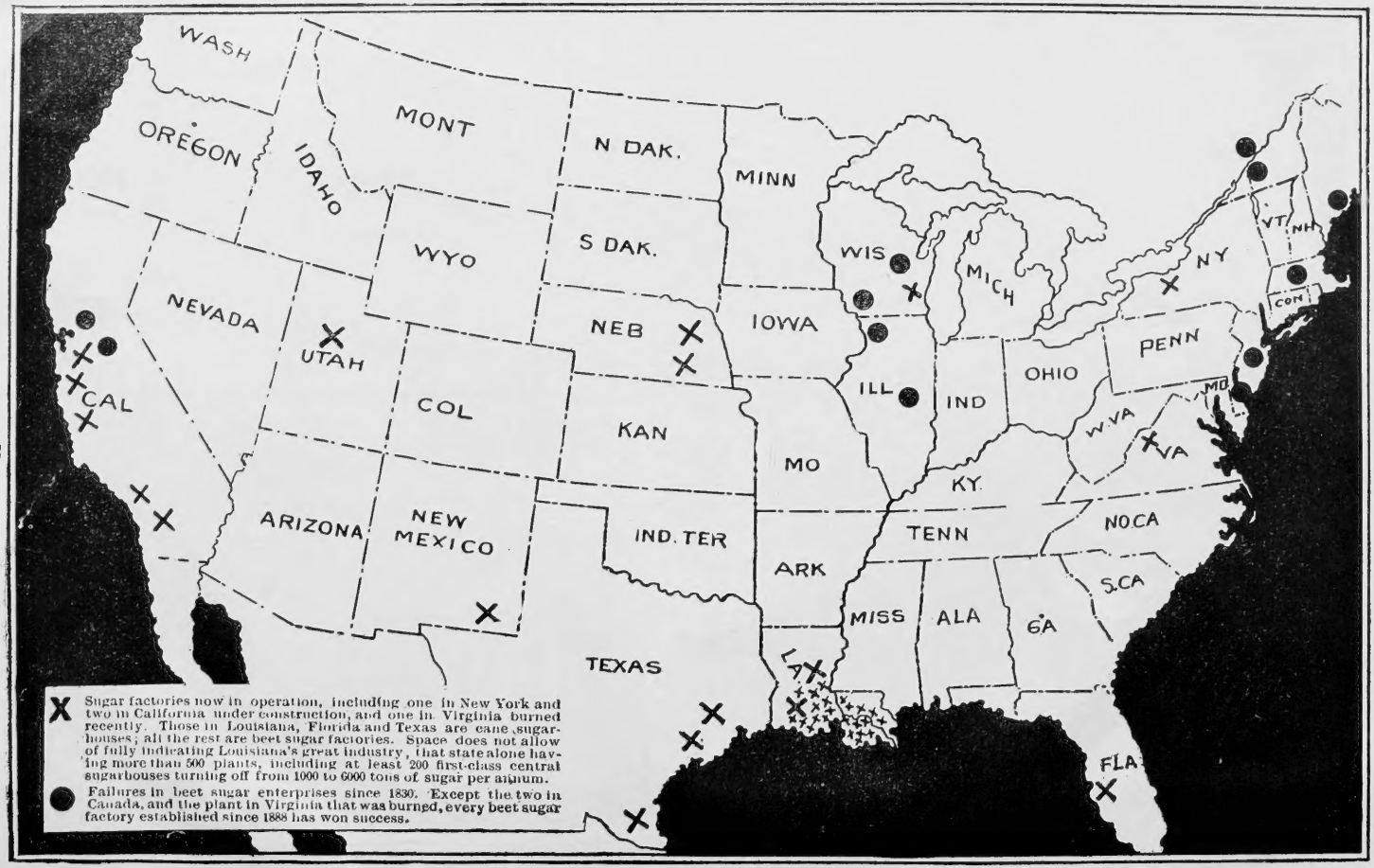
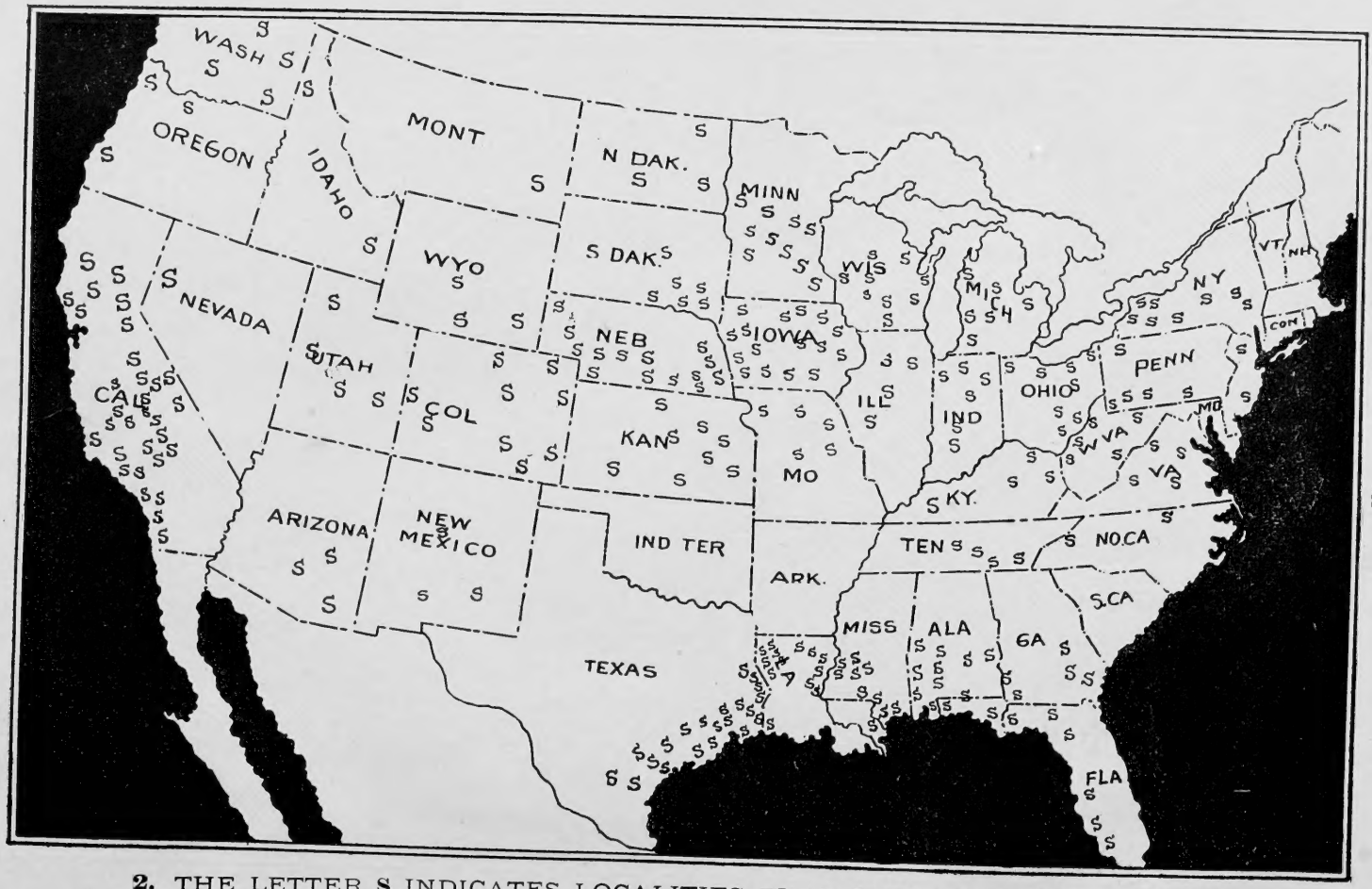
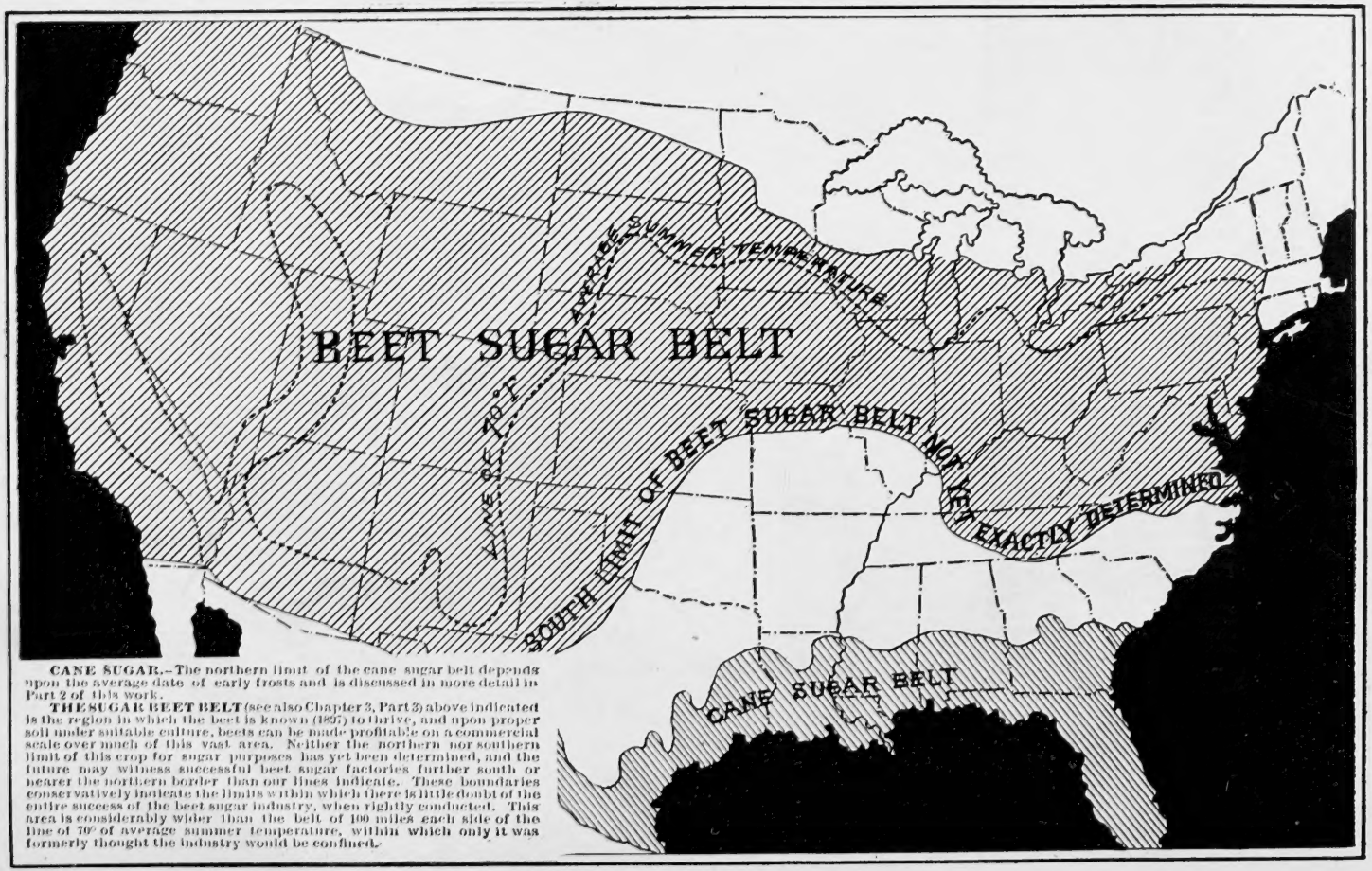


1. CHART OF (X) EXISTING (1897) SUGAR FACTORIES, AND (●) DEFUNCT.



2. THE LETTER S INDICATES LOCALITIES THAT WANT SUGAR FACTORIES.

In many of these sections organizations have already been started to promote factory enterprises. It is impossible to indicate upon so small a map the thousands of places at which farmers want to raise this new crop. Many localities not indicated hereon are anxious to secure factories.



CANE SUGAR.—The northern limit of the cane sugar belt depends upon the average date of early frosts and is discussed in more detail in Part 2 of this work.

THE SUGAR BEET BELT (see also Chapter 3, Part 3) above indicated is the region in which the beet is known (1895) to thrive, and upon proper soil under suitable culture, beets can be made profitable on a commercial scale over much of this vast area. Neither the northern nor southern limit of this crop for sugar purposes has yet been determined, and the future may witness successful beet sugar factories further south or nearer the northern border than our lines indicate. These boundaries conservatively indicate the limits within which there is little doubt of the entire success of the beet sugar industry, when rightly conducted. This area is considerably wider than the belt of 100 miles each side of the line of 70° of average summer temperature, within which only it was formerly thought the industry would be confined.

3. BEET SUGAR AND CANE SUGAR AREAS IN THE UNITED STATES.

SUGAR

A New and Profitable Industry

IN THE UNITED STATES

For Capital, Agriculture and Labor

—TO SUPPLY THE—

HOME MARKET YEARLY WITH
$100,000,000 OF ITS PRODUCT...

THE SUGAR INDUSTRY OF AMERICA

Its Past, Present and Future. How to enable our own people to produce all they consume, and thus put into their own pockets the vast sums now sent abroad annually to pay for imported sugar. A practical aid toward relieving agricultural depression, by affording hundreds of extensive home markets for thousands of acres of sugar beets and cane.

THE WHOLE SUGAR SITUATION

Comprehensively discussed, with illustrated descriptions of all cultural and factory processes, an index to the American sugar trade, and a directory of many localities that offer exceptional inducements to capital to embark in beet sugar and cane sugar. The plan of campaign of the American Sugar Growers' Society.

BY HERBERT MYRICK

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OUTLINE OF THIS WORK.

Author.—HERBERT MYRICK, editor American Agriculturist, Orange Judd Farmer, New England Homestead, Farm and Home; author (jointly with Col J. B. Killebrew) of "Leaf Tobacco: Its Culture and Cure, Marketing and Manufacture;" also of "How to Co-operate," etc, etc.; President Orange Judd Company, Treasurer American Sugar Growers' Society, etc, etc. Assisted by PROF W. C. STUBBS, director Louisiana Sugar Experiment Station, by various directors of State Agricultural Experiment Stations, and by numerous practical experts in the culture of sugar beets on a successful commercial scale. Embodying also the results of all work upon this subject by the United States Department of Agriculture.

Character.—IN GENERAL, the book aims to give an account of what has been done in the Beet and Cane sugar industry, just how it has been done, with reliable directions from actual recent experience under American conditions, that make it a guide to the farmer, capitalist, and others now or likely to be interested in any way in the sugar industry. Yet it is not blind to the fact that there is much to learn in this matter under American conditions.

Illustrated with over 100 ENGRAVINGS, mostly from photographs taken especially for this work, of beet sugar factory interiors and exteriors, cane sugarhouses, implements, etc., with maps showing the present conditions and possibilities of American sugar industry.

Part One.—THE AMERICAN SUGAR INDUSTRY IN ITS ECONOMIC ASPECTS —The farmer, the tariff and the sugar industry—Imports of sugar into United States —An economic crime—How competition of foreign sugar has grown—Present and future competition in sugar—Injustice of the Hawaiian treaty—The world's production of sugar—What of the United States—American farmers' demands—Can this country produce its own sugar?—Will the United States produce its own sugar?—Time necessary—The risk to capital—What stands in the way of the American sugar industry?—What is needed--Amount of protection required—Duty on sugar in the United States and other countries—Will protection enhance the price of sugar to consumers?—Why has not the American sugar industry developed more rapidly?—Farmers now mean business—American Sugar Growers' Society, its objects, plan of work and preliminary organization.

Part Two.—THE CANE SUGAR INDUSTRY—The area capable of growing sugar cane—Peculiarity of the crop—Present obstacles to the cane industry—The great

trouble in the sugar-cane industry—The soil adapted to sugar cane—How the soil is usually prepared—Culture—Harvesting—Rotation of crops—How to start the cane-sugar industry—Description of manufacture—Quality and grades of the product.

Part Three.—THE BEET SUGAR INDUSTRY IN AMERICA.

CHAPTER I.—WHAT HAS BEEN ACCOMPLISHED IN THE UNITED STATES—Failure of early attempts —An exception—Honor to whom honor is due—Recent development—The record in brief—What of the future—Elementary principles—Technical terms explained—Quality of the beet sugar—How beet sugar is made.

CHAPTER II.—HOW THE INDUSTRY HAS GROWN IN EACH STATE—California, the Spreckels enterprise at Watsonville—Alvarado's persistent fight and final triumph—The marvellous results at Chino—The new factories in California—Nebraska's trying experience and ultimate success—Wonderful results in Utah—In the Pecos Valley of New Mexico—The new factory in Wisconsin—Scientific and practical tests to demonstrate the adaptability of the sugar beet to conditions in the other States, including results of the 1896 crop.

CHAPTER III.—CULTURE OF THE SUGAR BEET—Climatic Conditions—Varieties of beets—Soils for the sugar beet—Rotation of crops—Feeding the plant—Plowing—More about subsoiling—Preparation of seed bed—Seeding—Hoeing—Thinning out—Irrigation—Harvesting—Storing beets—Feeding and storing beet pulp, tops and molasses.

CHAPTER IV.—COMMERCIAL ASPECTS OF THE BEET SUGAR INDUSTRY—Cost and profits of beet culture—Actual recent experience of practical farmers in raising beets on a large and small scale—How the industry employs and pays labor—Its manifold advantages—The brilliant promise to capital, provided the American market is reserved for American sugar—How to start a sugar factory, its location, requirements, equipment, management, etc—Cautions to all new to the industry.

Miscellaneous.—APPENDIX—A directory of some of the many communities that want beet sugar factories—Announcements of sugar engineers, contractors for sugar factory equipments, refining outfitters, seed dealers, beet lands, etc.

THE SUGAR INDUSTRY.

PART ONE.

THE ECONOMIC ASPECTS OF SUGAR.

THE FARMER, THE TARIFF AND THE SUGAR INDUSTRY.

It required every pound of the wheat and flour exported by the United States during the fiscal year 1896 to pay for the sugar imported.* The total value of all live and dressed beef, beef products and lard exported during the past year barely equaled the amount paid for imported sugar. Our immense export trade in cotton represents in value only twice as much as our import of sugar. Our vast exports of tobacco must be magnified thrice to counterbalance sugar imports. The barley, oats and rye, fruits and nuts, hops, vegetable oils, oleomargarine, butter and cheese, pork and hams that were exported last year all put together represent in value only two-thirds of the sugar imported.

IT IS AN ECONOMIC CRIME

to compel American farmers to raise staples in competition with the cheap-land-and-labor countries, with which to pay for imported sugar, besides standing the freight and commission both ways. No wonder agriculture is depressed, for not only are American farmers deprived of the home market for 100 million dollars' worth of sugar annually, but imports of other produce that can be grown within our borders average

* **Table A.**—IMPORTS OF SUGAR INTO THE UNITED STATES.

Expressed in millions of pounds.

Countries from which imported.	Calendar year ended Dec. 31.				Fiscal year ended June 30,	
	1879		**1894**		**1896.**	
Cuba, etc.,	1,360,000,000	Total	2,203,000,000	Total	986,000,000	Total
West Indies, Mexico, etc.,	117,000,000		362,000,000		546,000,000	
Central America,		**1,477,000,000**		**2,565,000,000**		**1,532,000,000**
Brazil,	63,000,000		258,000,000		191,000,000	
Other South American,	19,000,000		147,000,000		164,000,000	
South America,		**82,000,000**		**405,000,000**		**355,000,000**
Hawaii,	42,000,000		325,000,000		352,000,000	
East Indies,	167,000,000		420,000,000		701,000,000	
Oceanica,		**209,000,000**		**745,000,000**		**1,053,000,000**
*a*Europe,		**7,000,000**		**554,000,000**		**629,000,000**
Other countries,		**8,000,000**		**16,000,000**		**137,000,000**
Total,		**1,783,000,000**		**4,286,000,000**		**3,706,000,000**

a Includes for 1894, from Germany 355 million pounds, United Kingdom 49, Netherlands 12, France 14, Austria Hungary 44 and Belgium 80 million pounds.

a Includes for 1896, from Germany 450 million pounds, United Kingdom 37, Netherlands 7, Austria-Hungary 40, and Belgium 72, other Europe 21 million pounds.

120 million dollars per year more—wool, hides, cotton, tobacco, vegetables, breadstuffs, dairy produce, fruits and nuts, hops, hay, oils, rice, flaxseed, bristles, bark, sumach, chicory, eggs, hair, etc. Add imports of manufactures of hides, wool and cotton, most of which could be made in this country from domestic produce, and we have a total of nearly 300 million dollars a year, of which American farmers could, should and must have a larger share without necessarily curtailing their exports of farm products. Some officials wax jubilant over agricultural exports of 570 millions, apparently blind to the fact that fully half of these exports are required to pay for farm imports, exclusive of tea, coffee, and similar articles not now produced within our borders. Payments for these imports of raw produce and manufactures of them during the past six years have been 1¾ billions of dollars—twice as much as the entire interest-bearing national debt.

PRESENT AND FUTURE COMPETITION IN SUGAR.

The astonishing changes in the world's sugar situation during the past two years are revealed in Table B.* It will be seen that in spite of the almost annihilation of

* **Table B.**—MORE RECENT IMPORTS OF SUGAR INTO THE UNITED STATES—WITH THE QUANTITIES AND VALUES FOR THE ELEVEN MONTHS ENDED NOV. 30, 1896, COMPARED WITH LIKE PERIOD FOR 1895.

SUMMARY.

Not above No. 16, Dutch standard.	Pounds. 1895.	Values.	Pounds. 1896.	Values.
Beet sugar, duty,	197,518,466	$3,488,811	996,882,058	$21,664,611
Cane and other (under reciprocity treaty with Hawaiian Islands) free,	287,241,215	7,603,108	427,597,959	14,395,266
Cane sugar, duty,	2,829,002,221	52,791,998	2,314,671,164	51,159,954
Above No. 16, Dutch standard.				
Beet, cane and other, duty,	83,591,941	2,144,451	184,999,206	5,285,145
Total sugar, free,	287,241,215	$7,603,108	427,519,959	$14,395,266
Total sugar, duty,	3,110,112,628	58,425,260	3,496,552,428	78,109,710

IMPORTS IN DETAIL—FROM EUROPE.

Under No. 16, Dutch standard.	Pounds. 1895.	Values.	Pounds. 1896.	Values.
United Kingdom,	11,726,525	$223,296	34,817,129	$818,717
Austria-Hungary,	5,021,834	89,650	54,919,481	1,224,043
Belgium,	17,077,297	292,119	83,874,887	1,974,567
Germany,	167,085,525	2,973,033	814,792,974	17,505,183
Netherlands,	4,780,704	75,652	7,300,662	156,592
Other Europe,	5,569	345	21,437,146	489,532
British North America,	24,047,044	506,594	1,096,522	87,902
Total,	**229,744,498**	**$4,160,689**	**1,018,238,801**	**$22,256,536**

FROM "COUNTRIES TO THE SOUTH OF US."

Under No. 16, Dutch standard.	Pounds. 1895.	Values.	Pounds. 1896.	Values.
Central American States,	714,370	$9,087		
Mexico,	2,704,791	35,753	4,422,609	$77,482
British West Indies,	160,802,007	2,921,691	252,098,003	5,435,206
Cuba,	1,816,940,204	35,013,065	415,344,400	10,100,120
Other West Indies,	162,002,834	2,807,100	342,630,730	7,757,586
Brazil,			159,163,682	3,286,460
Other South America,	106,501,000	2,281,172	168,847,657	3,716,369
Total,	**2,249,665,206**	**$43,067,868**	**1,342,507,081**	**$31,073,223**

FROM THE "CHEAP LABOR" COUNTRIES OF THE ORIENT.

Under No. 16, Dutch standard.	Pounds. 1895.	Values.	Pounds. 1896.	Values.
China,	709,376	$15,334	368,389	$7,833
East Indies,	301,010,479	5,583,094	662,182,292	14,061,184
Hawaiian Islands,	287,241,215	7,603,108	427,519,959	14,395,210
Philippine Islands,	75,832,592	1,052,804	127,013,996	2,161,762
Other Asia and Oceanica,	56,243	926	31,021,036	823,692
Other countries,	148,012,975	1,989,339	475	14
Africa,	21,489,318	410,755	130,221,152	3,140,325
Total,	**834,352,198**	**$16,655,360**	**1,378,327,299**	**$34,590,020**

the industry in Cuba, total imports of sugar into the United States in 1896 were even more than in the previous year.

Still more remarkable is the fact that imports from Europe for '96 were five times as much as during the previous year. For the calendar year 1896 the United States paid Europe over $25,000,000 for sugar. All but a fraction of this was from sugar beets grown in Europe and worked into sugar at European factories, the shipment of which to this country was stimulated by export bounties. If Europe can make such an increase in *one year*, what may she not accomplish within the next five years, if the American market continues at her mercy?

Quite as momentous is the enormous increase during the past year in imports of sugar from the Orient. This sugar is largely grown by the coolie labor of China, the East Indies, the Philippines and Oceanica, or the fellah labor of Africa. English operators of Egyptian sugar plantations worked by fellahs for a few cents a day were paid over $3,000,000 for their sugar shipped to the United States last year, or eight times as much as the year previous. The increase from the coolie-grown product of the East Indies, and from the debased labor of the Philippine Islands, is equally as great. Unless protected against the yellow labor of the East, it is a question whether its manipulation of the sugar cane will yet crowd to the rear the forceful European beet-sugar industry.

Imports of cane sugar from "the countries to the south of us" show a decided falling off. In spite of the Cuban war, it is a matter of common notoriety that the competition of European beet sugars has so usurped the sugar markets of the world that the industry is no longer profitable under even the most favored natural conditions in British West Indies, and Her Majesty's government is now seeking some means of remedying the difficulty. Mr Gladstone and other British free-traders are outspoken against the German export bounty.

THE SANDWICH ISLAND INJUSTICE.

But the worst and most inexcusable phase of the sugar situation is the unjust, unfair, illegal, and unbusiness-like competition of sugar from the Hawaiian Islands. This sugar is admitted free under the reciprocity treaty which has been in effect with the Sandwich Islands since 1876. In the following twenty years, the United States sent to the Islands only $56,000,000 worth of exports, while we imported from the Islands $140,000,000 worth of sugar. The Islands have thus made $84,000,000 at the expense of the United States. The duties remitted on Hawaiian sugar since 1876 now amount to over $61,000,000. In other words, this government has allowed the Sandwich Islands over $61,000,000 in bounties to develop their cane-sugar industry at the expense of American farmers and to the loss of the federal revenues. Contract coolie labor is employed to raise this cane.

THE WORLD'S PRODUCTION OF SUGAR.

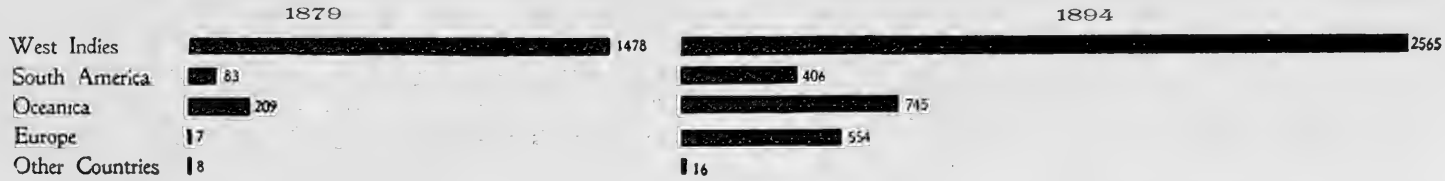
It is now two-thirds larger than ten years ago. Production and consumption are increasing between 6 and 7 per cent per annum. Thus the industry is doubling itself every fifteen years. Beet sugar was an insignificant quantity until within quite recent years. But look at its gain lately:

World's production.	Tons of 2240 pounds.		Gain per cent.
	1884	1894	
Beet sugar,	2,690,000	4,790,000	78
Cane sugar,	2,180,000	3,080,000	41

HOW THE COMPETITION OF FOREIGN SUGAR HAS GROWN.

WHERE THE SUGAR IMPORTED INTO THE UNITED STATES COMES FROM.

Illustrating the development of the industry abroad at the expense of American agriculture. The figures represent millions of pounds.

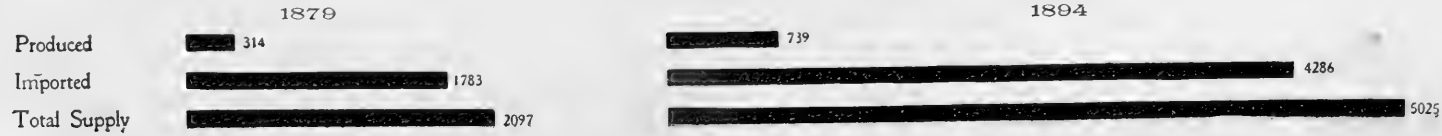


It will be noticed from Table A (see foot note on Page 1) in the fifteen years ended with 1894, imports of sugar into this country from the West Indies and Central America almost doubled, from South America our imports increased tenfold, from Oceanica (including the Sandwich Islands) threefold, other countries doubled their exports, but *Europe sent us* **80** *times as much sugar in* '94 *as in* '79. Comparing imports for the fiscal year 1896, there is a heavy falling off from Cuba, owing to the revolution in that unhappy country. South America sends almost as much. Oceanica shows an increase of 25 per cent over two years ago, and Europe almost as great increase. Still more significant is it that the 137 million pounds imported from other countries during the fiscal year 1896 came from Africa, which until recently never sent sugar to this market.

The graphic chart fails to bring out the remarkable facts about the way in which European beet sugar has usurped the place of Cuban sugar in our markets during the past two years. In eleven months of 1896, Germany sent to the United States 815 million pounds of sugar—five times as much as in the previous year. The United Kingdom sent us three times as much, Belgium and Austria-Hungary five times the quantity in the previous year.

INCREASE IN THE CONSUMPTION OF SUGAR IN THE UNITED STATES IN FIFTEEN YEARS.

The figures are millions of pounds, produced in the United States and imported in two calendar years.



A MODERN SUGAR HOUSE ON A LOUISIANA PLANTATION.

This Caffery plant, near Franklin, has a capacity of 75,000 tons of cane per season.

Thus the beet has gained twice as fast as the cane. The beet-root sugar grown in the temperate regions of Europe, and even as far north as cold Sweden, has, with the aid of the chemist and of the skilled manufacturer, overtaken and surpassed the cane of the tropics. The development has not been even, but its enormous proportions are manifest from this comparison:

DEVELOPMENT OF THE BEET SUGAR INDUSTRY IN EUROPE.

Production (tons of 2240 pounds)	1884	1894	Gain per cent.
Austria-Hungary,	653,000	1,050,000	**61**
Germany,	1,147,000	1,800,000	**57**
France,	303,000	814,000	**163**
Belgium,	116,000	230,000	**99**
Holland,	48,000	90,000	**88**
Russia,	406,000	600,000	**48**
Other European countries,	18,000	108,000	**500**
Total European sugar production (beet),	2,691,000	4,792,000	**78**

WHAT OF THE UNITED STATES.

Now, while these countries have been getting rich by growing sugar for the American market, our domestic sugar industry has been languishing, except for a brief spurt under the McKinley law, which was not in operation long enough for its influence to be fully exerted in the development of the American sugar industry. Here is a table which brings out the facts on these latter points:

Table C.—THE SUGAR TRADE OF THE UNITED STATES.

The figures for domestic production are from Willett & Gray's Sugar Statistical, the acknowledged authority, and were especially compiled by them for this work. The domestic crop each year is manufactured into sugar between August and February of the succeeding year. Hence, the figures are for the crop grown in the first year named in the first column, while the imports are for the fiscal year ended the June 30 following. Adding the domestic production and imports gives the total supply of sugar, from which the consumption per capita is estimated. The wholesale value of imported sugar is given as reported by the United States treasury department, whose official figures of quantities of imports are also used. The average value per pound of "fair refining" sugar each year is given in the last column. This, multiplied by the pounds of domestic sugar produced, gives the estimated wholesale value of the American product, though the figures are probably too high. This, added to the value of imported sugar, gives the total wholesale value of the sugar consumed in the United States each year.

[In long tons of 2240 pounds, as used in the sugar trade.]

Fiscal Years.	Domestic Production.			Imports.	Total.	U. S. Consumption.	Wholesale Value.			Value.
July 1 to June 30.	Cane. Tons.	Beet. Tons.	Total. Tons.	Foreign sugar. Tons.	Supply. Tons.	Per capita. Pounds.	Imp. Million dollars.	Dom.	Total. Dollars.	Average. Per lb.
1880-81	92,802	500	93,302	869,082	962,384	44	83.4	15.8	$99,200,000	7.58
1881-82	127,367	500	127,867	888,416	1,016,283	48	84.4	21.8	106,200,000	7.62
1882-83	76,373	500	76,873	954,316	1,031,189	51	84.3	12.5	96,800,000	7.25
1883-84	142,297	535	142,832	1,230,543	1,373,375	51	98.3	21.5	119,800,000	6.76
1884-85	135,243	953	136,196	1,213,341	1,349,537	52	72.6	16.1	88,700,000	5.27
1885-86	100,876	600	101,476	1,200,840	1,302,316	53	80.8	11.4	92,200,000	5.02
1886-87	135,158	800	135,958	1,400,108	1,536,066	53	78.5	14.9	93,400,000	4.88
1887-88	85,394	255	85,649	1,205,484	1,291,133	57	74.3	9.0	83,300,000	4.79
1888-89	167,814	1,910	169,724	1,233,122	1,402,846	53	88.6	19.2	107,800,000	5.05
1889-90	153,909	2,600	156,509	1,309,822	1,466,331	53	96.2	20.1	116,300,000	5.73
1890-91	136,503	2,800	139,303	1,555,123	1,694,426	66	95.1	15.7	110,800,000	5.01
1891-92	221,951	5,359	227,310	1,587,728	1,815,038	64	104.1	17.2	121,300,000	3.37
1892-93	165,437	12,091	177,528	1,486,656	1,664,184	64	116.2	11.2	127,400,000	2.81
1893-94	235,886	20,453	256,339	1,939,818	2,196,157	67	126.7	18.4	135,100,000	3.20
1894-95	271,336	20,443	291,889	1,595,808	1,887,697	64	75.0	16.9	91,900,000	2.60
1895-96	324,506	30,000	354,506	1,739,313	2,093,819	63	89.2	23.2	102,400,000	2.92
1896-97	243,220	40,000	283,220			?		20.0		3.16
Totals,	2,816,072	140,299	2,956,481	21,409,520	25,182,649		1447.7	284.9	1,692,600,000	

It appears from this table that in the sixteen years, 1880 to 1895 inclusive, the United States produced 2,673,000 long tons of sugar, or just about one-tenth of the

total consumption during this period. The table also shows that not only did the total consumption of sugar double in less than sixteen years, but the per capita consumption increased fully one-half during the same time.

It also appears that the United State paid out for imported sugar during these 16 years almost $1,500,000,000. If the imports of molasses, etc, were included and exports of saccharine deducted, the figures would show fully this amount. In other words, this country has paid out an average of just about $100,000,000 per year for sugar for nearly two decades, in the face of the steadily declining values of sugar indicated in the last column. Still more startling is the fact that our per capita consumption, around 65 pounds annually, is two and three times as much as the consumption in Germany, France and other sugar-producing countries.

THE AMERICAN FARMERS DEMAND

a fair chance to produce everything our people consume that can be grown in the United States. They want to begin with sugar, both cane and beet. Why? Because with reasonable protection and factories to work up these crops, sugar cane and sugar beets promise to afford farmers the new source of reasonable profits that are imperatively required to help relieve agricultural depression. Sugar beets at $4 to $5 per ton, or cane at corresponding prices, are fairly profitable crops compared to cereals, potatoes, tobacco, cotton, etc.

An acre of corn at the west, yielding 40 bushels of grain worth 15c per bushel, will buy something more than 100 lbs of granulated sugar at the grocery store. That same acre of land devoted to sugar beets will produce 2000 to 3000 lbs of refined sugar, like the finest white sugar you can buy. The corn under such conditions returns about $6 per acre for all the labor and capital invested in that crop. Sugar beets yield $25 to $50 per acre, and while they require far more labor, they pay for it and leave a net profit of $10 to $25 per acre, which is handsome compared to the meager returns from corn, wheat, oats, etc.

SUGAR AND THE MONETARY PROBLEM.

The country has been convulsed over the proposition of free silver coinage at 16 to 1. The most ardent advocates of that policy have not proposed to coin more than 100,000,000 silver dollars per year. Now without discussing the pros and cons of the silver question, no one will deny the benefits that would accrue by keeping at home the 100,000,000 of (gold standard) dollars that are sent out of the country each year for sugar. If this sugar is all paid for in money (instead of partly in merchandise), keeping at home this vast sum would inflate our per capita circulation nearly $1.50 each year, or $15 in ten years, and in 15 years it would double our present per capita circulation. Certainly it would help to solve the currency problem to keep at home the money that now goes abroad for sugar.

CAN THIS COUNTRY PRODUCE ITS OWN SUGAR?

There is no longer any doubt about it. The sugar beet can be grown over a large part of the United States, and in some sections attains a perfection never approached in other countries.

The sugar cane is adapted to a far larger area than has been generally supposed.

The maps forming the frontispieces to this book show the probable possible distribution of these commercial crops. The lines on the map No 3 are based on the

latest and best practical experience. It is not denied that either of these sugar crops will succeed better in certain localities and climates, upon certain soils, fertilizers, etc, than under other conditions. The regions that offer the best natural and artificial advantages for the industry are to be carefully ascertained, but they will be found within the the spaces indicated on our map. Chart No 1 shows the present location of sugar factories.

In Map No 2 we indicate the counties that have already started a movement to secure a sugar factory. In some of these counties several towns are aspirants for the factory. Many of these efforts are as yet unorganized and are being pushed with scant knowledge of the requirements of the industry. But in many cases, the farmers have abundantly demonstrated that they can furnish beets of necessary quantity and quality to supply a factory, local capitalists are interested, and it only needs favorable legislation and good business management to speedily establish the industry in such places.

WILL THE UNITED STATES PRODUCE ITS OWN SUGAR?

Yes, if congress gives our farmers a chance to do so. The following pages show what has been done. The exhibit is the best possible proof of what will be done in future if the industry is given a fair chance.

In four years—1892 to 1895—the domestic production of cane sugar jumped from 165,000 to 324,000 tons. Of beet sugar, the domestic production was 255 tons in 1887, 5,359 tons in 1891, 20,000 tons each year 1893-4, 30,000 tons in 1895 and for the campaign of 1896 makes the handsome total of 40,000 tons. Imports of beet sugar in the twelve months of 1896 reached 523,000 tons.

The statement in the following pages of what has been accomplished with sugar in the United States is the most complete and up-to-date yet published. Our effort has been to make it so brief that all will read it, so clear that all will understand it, so comprehensive that all will grasp the possibilities of the American sugar industry, so reliable that this work may be a faithful aid to all at present or in future interested in this industry, whether as statesman, capitalist, manufacturer, farmer, laborer or consumer.

TIME NECESSARY—THE RISK TO CAPITAL.

Beet culture, however, cannot be learned in a single season. It is high farming, intensive horticulture, like the market gardening near our great cities, which is the result of fifty years of experience. Under the best management it takes from two to four seasons for the farmers in any locality to learn how to grow beets to the best advantage. Until this is done, the sugar factory is not assured of an abundant supply of beets of proper quality. Meanwhile the immense investment is at risk—from $200,000 upward in each factory, and at best the factories can run only 100 or 150 days during the year. Experience in this country has demonstrated that where the industry has survived this first stage, it has in every case become well established, to the satisfaction and profit of the farmers, laborers, railroads and capitalists interested in the business.

WHAT STANDS IN THE WAY OF THE AMERICAN SUGAR INDUSTRY.

Mainly European competition. Europe is now sending us nearly 100 times as much beet sugar as she did 15 or 17 years ago. She has developed her beet-sugar

THE GREAT BOILER ROOM OF A BEET SUGAR FACTORY.

From a photograph of the plant at Chino, southern California. The fuel is oil, 80,000 barrels being consumed per season to operate the 2,400 horse power engines.

industry by a liberal system of direct subsidies, high protection and export bounties, until the European beet-sugar industry has practically ruined the cane-sugar industry of the tropics and monopolized the sugar market of the world. To complete the destruction of the American sugar industry, or at least to prevent the further development of the beet-sugar business in this country, Germany has recently increased its export bounty. And France is about to follow suit, thus enabling their sugar to be sold in the United States below the cost of production in this country. The United States is supporting the sugar industry of Europe at the expense of the American farmer.

WHAT IS NEEDED

is a reasonable specific duty on all imported sugar, with an additional discriminating duty from countries paying an export bounty, equal to that bounty. Then with such aid as the various states and localities interested may offer to secure sugar factories, the beet-sugar industry could be put on its feet in this country, within a very few years.

It would afford farmers the new and profitable crop that they must have. It would also offer a new market for labor and an immense business to machine builders, railroads and others, and a fair return on the capital invested in the business, and it would distribute among these people the 100 million dollars that are now paid annually for imported sugar—a billion dollars during the past ten years! Americans being the greatest users of sugar in the world, its consumption here has doubled in 15 years and is likely to increase in the same ratio in future. Thus by 1910, if the domestic industry supplies the home market as it should, it will be putting into the pockets of our people 200 million dollars a year that otherwise would be sent out of the country.

We want to divert capital from further investment in refineries on the Atlantic coast to refine imported raw sugar, and induce capital to invest in the hundreds of new factories that will be required to work up the amount of beets and cane necessary to supply the home market with sugar. To build and equip these factories, and to supply the paraphernalia incident to this vast industry, means an investment of $300,000,000 or so.

AMOUNT OF PROTECTION NEEDED.

Opinions differ as to the precise figure, but all are agreed upon the points made in the preceding paragraph. Also that the new tariff should go into effect promptly, so capital and agriculture may know what to bank on, and that no reciprocity to the detriment of sugar should be enacted. The tariff of 1883 imposed a duty of about 2c per lb on raw sugar, which yielded a revenue of $54,000,000. Some such rate, with a fraction of a cent per lb bounty on domestic sugar (to be gradually reduced) to directly encourage it and to protect it against unscrupulous competition by the sugar trust, would doubtless be sufficient.

It will be seen from the table below (Table D) that the proposed duty in the United States of about 2c per lb on the best grades of imported raw sugar is only one-third to one-half as much as the present duties on sugar imposed by European countries. It is this high protection, coupled with direct subsidies and export bounties, which has brought about the immense development of the beet-sugar industry on

the continent. The present bounty in Germany is about $\frac{1}{8}$c per lb on all sugar produced and an additional export bounty of over $\frac{1}{4}$c per lb on raw and more than $\frac{1}{8}$c per lb on refined sugar. Direct bounties paid the European sugar producer in 1894 amounted to more than $25,000,000.

The average rate of duty imposed on raw sugar by the eight European nations named below is now 4.86c per lb, almost as much as the United States' war tariff of 5c per lb. The most that has been suggested for American sugar, including both duty and bounty, is only one-half the present European duty.

In the earlier years of our government the duty on sugar varied from $2\frac{1}{2}$ to 5c per lb. Of late years, the policy of the United States toward sugar has been as follows, and the present duties on sugar imposed by certain foreign countries are also given:

Table D.—RATES OF DUTY ON BEST GRADES OF IMPORTED SUGAR (in cents per lb).

UNITED STATES.	PRESENT DUTIES IMPOSED BY OTHER COUNTRIES.
1861, 5 cents per pound,	Germany, 3.9 to 4.75 cents per pound,
1862, 4 cents per pound,	Austria-Hungary, 3.9 to 4.11 cents per pound,
1864, 5 cents per pound,	Belgium, 3.94 to 4. 36 cents per pound,
1870, 4 cents per pound,	Holland, 4.8 cents per pound,
1874, 5 cents per pound,	Russia, 6.6 to 8.88 cents per pound,
1883, $2\frac{1}{3}$ to $3\frac{1}{2}$ cents per pound,	Italy, 5.25 to 8.35 cents per pound,
1890, $\frac{1}{2}$c duty, bounty on domestic sugar 2c per lb,	Spain, $4\frac{1}{2}$ cents on foreign,
1894, 40 per cent ad valorem,	Spain, 2.94 cents on colonial,
	France, 6 to 7.45 cents per pound.

The highest figures for the United States are for refined sugar, but raws constitute the bulk of imports. In the figures for foreign countries the smaller amount is for raw and the larger amount for refined sugar.

AS TO STATE BOUNTIES.

These have been tried in Utah and Nebraska, but a bounty offered by the state has proved to be an ephemeral thing. It has lasted only from one to three years and in no case has proven to be perfectly satisfactory to either the state treasury, the public, or the farmers or manufacturers directly interested in the sugar industry. It is urged against state bounties that they give an artificial stimulus to the business that is not conducive to substantial development or to the best results in field or factory.

The general opinion favors appropriate protection against foreign competition for a sufficient term of years to give our domestic industry a fair chance. The investment required is so large that capitalists will not go into the industry unless there is reasonable assurance of its being successful for a long term of years. This hinges on protection against foreign competition, rather than upon any little aid for a year or two that might be given by a state bounty.

Moreover, the state bounties encourage the industry in one state of course more than in another. Protection or direct aid in the form of bounties should be national in scope. Then each and every state will be on the same footing and the industry will naturally develop along substantial lines in those sections that offer the best natural inducements to its permanent success.

WILL PROTECTION ENHANCE THE PRICE OF SUGAR TO DOMESTIC CONSUMERS?

No. Recent experience and the present status of the industry go to show that with proper protection there will be such an increase in the production of domestic sugar that, with the large imports which will continue, the market will be so well sup-

plied as not to materially advance prices. It is possible that for a year or two the consumer may not be able to get within from one to two pounds as much sugar for a dollar as under the unprecedentedly low prices of the past year. The average value of vacuum-pan Louisiana sugar during the period covered by the tariff of 1883 was 5.68c per lb, while under the Wilson bill it was 3.45c. Adding the difference between the average duty in 1889, 2.02c, and the present average duty of 0.87c, say 1.15c, we get 4.6c as the selling price under the proposed rate of duty. This price is fully one cent below the price prior to 1890.

In no market of Europe where the 5,000,000 tons of beet sugar are produced can the retailer procure his supply of consumable sugar so cheaply. It appears paradoxical that this very sugar, which by its cheapness in outside markets breaks down the value of American sugar to the starving point, should be so costly at home, but the explanation is easy. These countries impose a heavy tax on their home consumption in order to pay an export bounty on the crop. The German empire this year will produce some 2,000,000 tons of beet sugar and consume less than 600,000 tons, exporting 1,400,000 tons. In Germany each factory pays a license of from $800 to $2500, according to size, and a tax of 2.1c per lb on all sugar sold to be consumed in Germany.

WHY HAS NOT THE AMERICAN SUGAR INDUSTRY DEVELOPED MORE RAPIDLY?

Because when the sugar beet was first tried, 20 and 25 years ago, other crops paid so much better that farmers did not have the patience to learn how to grow beets. The first factories were not well located to secure an abundant supply of rich beets. The whole thing was comparatively new, and beets were of poorer quality than now. Then, 10 and 12 per cent of sugar in the beets was considered fair; now anything below 12 per cent is not accepted at the factory, averages of 14 to 15 per cent over large areas are not uncommon, while tests of 18 to 24 per cent sugar in American beets are on record. The beet is a thoroughbred that improves in richness as a result of proper inbreeding and care. Another powerful obstacle to the beet-sugar industry in America 10 and 20 years ago was, that with dollar wheat and virgin land free of cost, other crops were more profitable in comparison with the labor involved.

With sugar cane, the industry prior to the war was conducted by slave labor and without much enterprise, the increase in slaves being an element of the profits. The industry was destroyed during the war. It took 20 years thereafter and an expenditure of $21,000,000 to rebuild the levees and reclaim the plantations, and it was not until 1878 that Louisiana's product was restored to the figures of 1844—115,000 tons. From 1878 to 1886 there was much trouble with high water and crevasses, while as early as 1884 an era of low prices set in, which were helped by a reduced scale of duties. Almost any other industry would have succumbed to such adverse influences, but our sugar producers, though discouraged, would not admit defeat. They established an experiment station to learn more about fertilizing and chemical control of sugarhouse work, changed in a large measure to the central factory system—just as the dairy people have done—improved the sugarhouse equipment and by 1890 had doubled the crop of 1878. Then came the "bounty" period, in which the growth of production in four years was from 165,000 tons to 324,000 tons. Had that law been kept in force we would, at that rate, have produced 1,830,000 tons in 1905 and from

AMERICA'S RECORD-BREAKING BEET SUGAR FACTORY, AT WATSONVILLE, CAL.

In 170 days, 1896-7 campaign, it worked 160,000 tons of beets into over 20,000 tons of sugar paying farmers for beets over $650,000.

beet root, by parity of reasoning, some 480,000 would have been produced—or 2,310,000 tons of sugar, which is about 5 per cent over what we now consume.

But with low duties and lower prices, many planters could not meet their obligations. An idea of the disaster is given by the sale of Rosehill plantation of 1200 acres and a factory whose machinery cost over $100,000, which was sold by the sheriff for $15,000, while the Marshfield plantation of 2000 acres sold for $5500, including stock and tools.

Another reason why the beet-sugar industry did not develop much until 1890, was that the United States department of agriculture, discouraged by a few failures or blind to the merits of the beet root, led a wild-goose chase after sorghum. The possibilities of sorghum are not denied, but the practical realities of cane and beets are such as to eclipse sorghum for commercial purposes. After it had been demonstrated that sorghum was not a reliable sugar plant, as compared with sugar cane or the beet root, government spent millions of money and years of time upon it. Sorghum could be cheaply raised like corn, was not a "back-bending crop" like the beet. The *American Agriculturist* did what it could to stem the sorghum craze by showing what the beet-sugar industry was doing in practice compared to the meager results of the sorghum theory, but it took years of bitter and costly experience on the part of government and farmers to vindicate our position. So the sorghum craze, fed from national and state treasuries, swept over the country for a dozen years.

But as it exploded, more work was done with sugar beets, until, when the McKinley law was enacted, experience had pointed out the way to the success that has since been achieved. But hardly had a few beet-sugar factories been established under the McKinley act before its repeal was ordered by the people. This brought the industry to a standstill until the prospect of a change in administration, the absolute necessity of a new crop to relieve agricultural depression, and further successful experience with existing factories, makes the time ripe for a grand effort to supply the American market with American sugar.

FARMERS MEAN BUSINESS.

Farmers are now very emphatic in this demand. During the past sixty days farmers' organizations have been founded in several hundred counties to advance their interests in raising sugar beets and cane, in securing factories to work up the crop, to obtain needed legislation to develop the industry and to protect it against the trust. This organization is now growing with great vigor. Farmers realize what the sugar proposition means to them. They are organizing to co-operate with labor and capital to establish the industry. They demand whatever reasonable legislation is needed to pave the way for such establishment of sugar factories. They will reward the political party that stands by them and punish their representatives who go back on them. They care more for their bread and butter, and will act accordingly.

The American Sugar Growers' Society.

OBJECTS.

1. To secure for American farmers, laborers and capitalists the American market for American-grown sugar, instead of having the American market supplied with the

product of the highly protected and bounty-fostered beet-sugar industry of Europe, or of the cane-sugar industry of the cheap-labor countries of Africa and the east.

2. To put into the pockets of the American people the $100,000,000 now sent abroad annually for imported sugar—one billion dollars every ten years. A sum which within a dozen years or so may be $200,000,000 annually.

3. To show the American people that this upbuilding of what is destined to be one of the greatest of American industries and one of the most beneficent to American agriculture, can be done without injustice to others and without unduly advancing prices to consumers, but so that the enormous sums now sent out of the country every year may be distributed among our own farmers and others engaged in cultivating the thousands of acres of sugar beets and cane, and in operating the hundreds of enormous factories required to supply the people of the United States with sugar.

4. These results to be aided by (1) appropriate tariff legislation to offset foreign export bounties and to afford reasonable protection against foreign competition; and (2) by whatever encouragement may be offered by the respective states and by the localities that desire to secure sugar factories.

5. In addition to these objects, the American Sugar Growers' Society, through its local and state organizations, will encourage farmers to become experts in beet culture, will act as a medium through which capitalists and others who wish to start factories may reach localities that want factories, and will in every proper, reasonable and legitimate way do all in its power to promote the best development of our domestic sugar industry. The Society will resist and try to prevent or circumvent any unjust action toward the industry that may be attempted by the sugar trust, and will do its utmost to secure for the growers of beets and cane the fullest measure of whatever help may be extended to the industry by state or nation.

ITS PLAN OF WORK.

This is a non-secret, non-partisan, and strictly businesslike organization to carry out the above objects.

It consists of national, state, congress, district and local societies. The national or American Sugar Growers' Society has general supervision of the movement and the work of organization. State societies afford a means of bringing together representatives from local and district societies for mutual benefit and to attend to state matters affecting the sugar industry. The local society is the unit, and it may cover one or more townships or a whole county, provided that any question over conflicting jurisdiction be settled by the national office. The local society is the medium for active work in legislation, in experiments in the culture of beets or cane, in disseminating information, in securing factories, etc. Each local society is entitled to one delegate for every five members in making up the district societies, whose territory is bounded by the limits of the United States congress district. The special purpose of the congressional district society is to enlighten your member of congress upon this subject, also both United States senators from your state, and to make them acquainted with your wants and demands, to the end that they may spare no effort

in congress to secure prompt action favorable to your interests as present or prospective producers of sugar crops.

OFFICERS OF THE ORGANIZATION.

President—R. M. ALLEN, Ames, Neb. President Nebraska Beet Sugar Growers' Association.

Vice President—CHARLES A. FARWELL, New Orleans, La. President United States Cane Growers' Association.

Treasurer—HERBERT MYRICK, 52 Lafayette Place, New York. President Orange Judd Company, and editor American Agriculturist, New York, and Orange Judd Farmer, Chicago, Ill.

Secretary—B. W. SNOW, Marquette Building, Chicago, Ill. Statistician Orange Judd Farmer.

Executive Committee—The foregoing and one vice president for each state.

SOME NEBRASKA SUGAR BEETS.

PART TWO.

THE CANE SUGAR INDUSTRY.

BY PROF. W. C. STUBBS,

Director Louisiana sugar experiment station at Audubon Park, New Orleans; director Louisiana state experiment station at Baton Rouge, director of the North Louisiana experiment station at Calhoun, etc, etc.

NOTE.—This chapter is designed to give a clear insight into this great industry at the South, but elaborate details of culture and management are omitted, because the industry is an old established one, and these matters are generally known to those now engaged in or likely to enter into the cane sugar industry.—[H. M.

CUTTING SUGAR CANE, LOUISIANA.

PHOTO BY MUGNIER, NEW ORLEANS.

PART TWO.

THE CANE SUGAR INDUSTRY.

CHARLES A. FARWELL,
First vice president American Sugar Growers' Society, President United States Cane Planters' Association, New Orleans, La. Having been in the sugar business all his life, and possessing the confidence of the whole sugar interests of the South, Mr. Farwell is a type of the men who are doing so much to develop this and other great industries in the South and throughout the country.

A BRIEF HISTORY of this industry is given on Page 12, from which it will be seen that it is a very old industry, although its principal development dates from about 1885. Cane was originally introduced into Louisiana by the Jesuits from San Domingo in 1757, but the ribbon cane now generally planted was introduced via Georgia from the island of St Eustatius. There are many varieties of cane and these are being daily increased by additions obtained from the planting of the true seed of the cane. The Louisiana sugar experiment station at Audubon park, New Orleans, is experimenting with over 100 varieties; of these, however, only two kinds are in general use in the state—the Purple or Black Java, and the Purple Striped Ribbon cane. A few planters grow a white variety known as the Light Java. These varieties were introduced about the year 1825 and have become so thoroughly acclimated to our soil and climate that they are now almost universally used.

THE AREA CAPABLE OF GROWING SUGAR CANE

is far larger than has been supposed. The sugar cane belt can be extended along the Gulf coast from a point near Savannah, Ga, running almost parallel to the coast line, to the northern extremity of Louisiana and on through Texas to the Rio Grande river. If irrigation could be secured, a portion of Arizona and New Mexico could also be utilized for this crop.

The area of cane in Louisiana for 1896-7 is about 300,000 acres. This amount can

oe increased tenfold. In fact, I may almost say, without fear of contradiction, that there is hardly an acre in Louisiana that is not available for sugar cane under intelligent culture.

PECULIARITY OF THE CROP.

Cane culture has one peculiar feature, not possessed by hardly any other plant cultivated in the United States. The large amount of cane necessary to plant an acre (from four to six tons) makes it necessary to go slowly in the establishment of a large plantation. The usual method is to buy a carload or two of cane, plant a few acres and then use the entire crop of the next year in planting a larger acreage, and then the third year the entire crop in planting the plantation. In this way, it may be said to require three years to get into the cane culture upon a full scale. For this reason, the increasing and decreasing of a cane crop must be done gradually, and is unlike the beets, which can be increased or decreased annually at the will of the planter.

PRESENT OBSTACLES TO THE CANE INDUSTRY.

There is no doubt the area of cane will be greatly extended in the near future if we can receive substantial assurances of a permanent support against foreign competition. At present, capitalists hesitate to invest in an industry the prices of whose product are more or less influenced by a changeable congress at Washington. A permanent tariff is desired, in order that we may know and publish to the world what the profits will be under such a system. Having determined the profits, it will be easy (if the profits be remunerative), to secure capital to develop the large areas adaptable to the sugar cane.

THE GREAT TROUBLE IN THE SUGAR CANE INDUSTRY

is the large cost of the machinery necessary to economically manufacture the cane. We have reached that point in the development of this industry, that the larger the factory the more economical the manufacture of cane into sugar. There seems to be no limit in the expansion of the sugarhouse. We have several in this state that are now working as high as from 1000 to 1500 tons of cane per day. This gives a factory the capacity of working 60,000 to 70,000 tons of cane in a season and some are able to work up even 100,000 tons.

The clientele attached to such a sugarhouse is but little larger or more expensive than one for a sugarhouse taking off 200 to 300 tons per day. In these days of close competition and small profit, the large sugarhouse will survive, while the small one must inevitably surrender. Hence, in establishing central factories, it is now the purpose to build as large as possible so as to make the manufacturing expense of cane as low as possible per ton.

To build and equip such a factory as this requires hundreds of thousands of dollars. These factories run only sixty to ninety days in a year, hence requiring the highest intelligence in every department to make the profit in these sixty or ninety days necessary to pay good interest upon the investment. The running of this sugarhouse machinery night and day, from start to finish, often hurried by the advent of a disastrous frost, causes a wear and tear which would not occur if it could be kept running regularly throughout the year, and at a regular rate of speed.

Moreover, while the sugarhouse is idle during nine or ten months of the year, the outfit depreciates in value, for idleness may be as injurious to machinery as wear

SUGAR HOUSE, EVAN HALL PLANTATION, LOUISIANA.

and tear. Hence the depreciation account of a sugarhouse is a very large item. It will be seen from this how different this industry is from running a refinery on raw sugar the year through, and how different it is from other kinds of manufacturing.

THE SOIL BEST ADAPTED TO SUGAR CANE

is a sandy loam, rich in vegetable matter. The cane does not seed, and since we grow it exclusively for sugar, the draft upon the soil is not heavy, provided the fodder and tops, the bagasse from the mill, and the ashes from the sugarhouse, are all carefully returned to the soil. But to make a crop profitable, a large amount of tonnage must be secured. It is nothing unusual to secure a crop of 40 to 45 tons of stripped cane per acre (though 20 tons is a fair average over a large area). Forty tons means fully 70 tons of green matter growing upon one acre of land; and while the per cent of nitrogen, phosphoric acid and potash is comparatively small, the aggregate of these three ingredients removed from the soil by such a crop is large.

The cane seems to be specially adapted to soils of an alluvial character on account of the tendency of these soils to make weed. The "raging fertility" of such soils has to be dampened by the growth of just such crops as sugar cane, which is a gigantic grass, before it can be adapted to the growth of cereals or other crops raised exclusively for the seed. Hence, the alluvial lands of Louisiana are peculiarly and singularly adapted to the cultivation of cane.

THE SOIL IS USUALLY PREPARED

in the following manner: Thoroughly broken with two to four horse plows, thrown up in beds six to seven feet in width, the middles deeply plowed and opened, and at intervals of short distances, what are termed quarter drains, running at right angles to the rows, are cut, leading into the ditches so that excessive rainfalls may be carried off without injury to the soil. This plowing is usually done in the fall;—though sometimes, from necessity, it is forced into the spring.

PLANTING.

After the soil is well prepared, the rows are opened with a double mold board plow, and the canes are deposited in this furrow—two to three continuous canes along the whole length of the row. These canes are then cut with a cane knife to adjust them to the ow, and covered either with a plow, a cultivator, or with a hoe. The planting is done any time between September and April. It is usually done by hand, though we have one or two cane-planting machines that have been experimenting in this line. After the cane has been planted, from each joint where is an "eye," springs a sprout. To assist this sprout in reaching the surface early in the spring, it is customary to scrape off the excess of dirt which was placed on the cane in the fall or early spring in order to protect it against the cold.

CULTURE.

After the cane has obtained a "stand," it is then cultivated, largely after the order of corn, care being taken to preserve always the cane upon a ridge so that the excessive rainfalls of summer may be easily disposed of. It is usually laid by in June

A CANE SUGAR PLANTATION IN SOUTHERN FLORIDA.

or early in July. After "lay by," the cane grows very rapidly, particularly if frequent showers at short intervals conspire with warm weather.

After the cane is planted we usually get two crops, sometimes three, from the same planting. The first crop is usually termed the "plant cane," and the second and third "first stubble" or rattoons. Cane is planted in this state so as to secure a continuous stand at maturity of from three to five stalks to the running foot. The stalks usually weigh from 2 to 4 lbs apiece. Like all grasses, cane tillers or suckers very greatly, and during the summer months many of these suckers or tillers perish. Hence the necessity of not planting cane too thick or too thin. If planted thickly, it will exhaust its energies in trying to sucker—a natural quality which seems to be exercised. If planted too thinly, the field will be filled at harvest with a large proportion of immature suckers, low in sugar.

HARVESTING.

In Louisiana the general harvest begins in October and lasts till January. In tropical countries grinding does not begin before January and usually lasts till June or July. In Louisiana, on account of the severity of our winter, cane must be harvested in the fall and winter or be killed. It is therefore only about eight or nine months old when worked in the sugarhouse. In tropical countries it is frequently fifteen and sometimes eighteen months old when harvested. Hence the superiority of tropical canes in sucrose over those grown in the southern part of this country.

In the latitude of southern Louisiana, we make a crop every year, while in the tropics only two crops are made in three years. Our less yield per acre than in the tropics is therefore somewhat made up. But, per contra, in the tropics, they only plant cane once in four to six years, while we must plant every other year.

ROTATION OF CROPS.

In Louisiana the regular rotation of cane is as follows: Cane, two or three years, and then followed with corn, sown broadcast at lay by with cowpeas (usually the clay variety), and the entire mass of vines and stalks turned under in August or September, and replanted in cane.

HOW TO START THE CANE SUGAR INDUSTRY.

A community can experiment to demonstrate what it can do with sugar cane in this way:

Let each individual plant sugar cane on a small area and manufacture it on a small scale, with horse mills and open evaporators, according to the old-fashioned system. In this way, the saccharine content of their cane and the average available tonnage per acre can be established. Then, they can present to the commercial world a valid argument to enlist capital in a factory. The average yield being say 20 tons per acre, 5000 acres would be required to furnish the maximum crop of 100,000 tons that can be worked up in a single season by a modern factory of large size. Certainly nothing less than 2500 acres under cane each year would answer for a modern factory.

The Louisiana experiment station at Baton Rouge has published a bulletin (No. 5) giving full directions about sugar making on a small scale, which also gives direc-

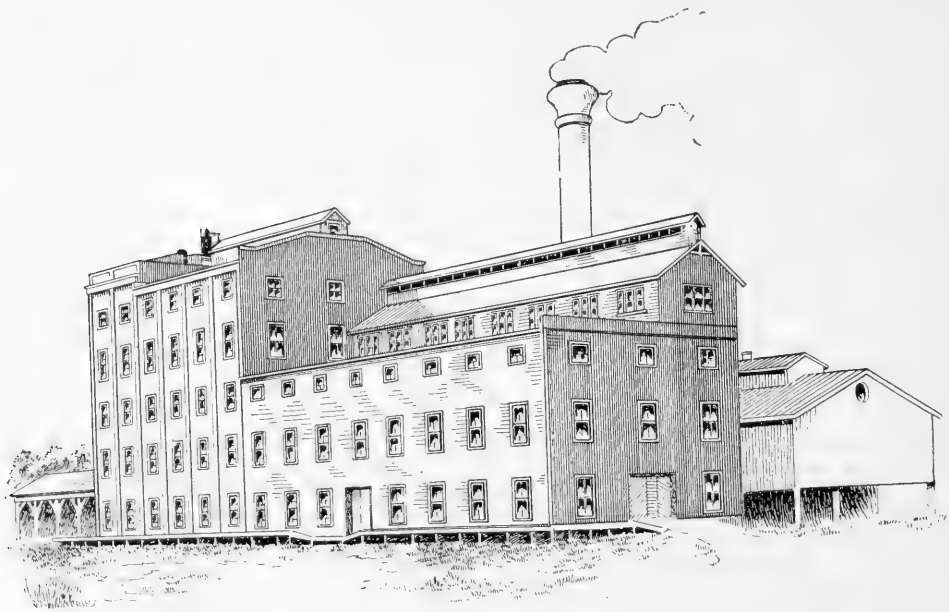
NEGRO QUARTERS, EVAN HALL SUGAR PLANTATION, LOUISIANA.

tions for culture of the cane in a small way. A copy of it will be sent free to anyone who applies to Baton Rouge for it in person or by mail.

The difficulties in securing a central factory for working up sugar cane are dependent entirely upon the slowness with which sugar cane plantations can be established. Cane plantations must be established before the factory will be secured, and farmers are slow to establish a crop which requires three years of work and patience, unless they have "an assurance doubly assured" of a factory.

DESCRIPTION OF MANUFACTURE.

Cane is hauled from the field and dumped alongside a moving platform, which



SUGARHOUSE ON ADELINE PLANTATION, FRANKLIN, LA.

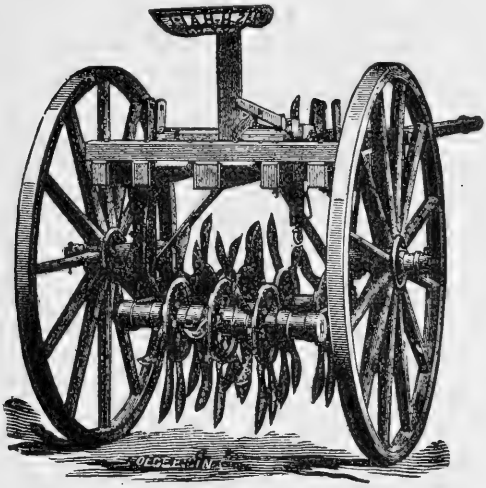
This plant is owned and operated by the Oxnard family, who are also interested in the beet sugar factories at Norfolk and Grand Island, Nebraska, and Chino, California. Like the latter plant, the Adeline sugarhouse has all modern improvements. This is the only instance we know of in the United States in which the comparative merits of the cane and beet have been closely compared for a series of years.

conveys it to the mill, and drops it, end on, into a chute which abuts upon the first mill—generally a three-roller mill, giving two pressures. Thence a conveyor takes the crushed cane to a second mill, where it gets a final squeezing and is ejected in a pretty dry state (called "bagasse"). This is conveyed by a third carrier to the bagasse furnace, wherein it is consumed as fuel and supplies steam power and steam heat to the sugar house.

Or, the cane may be cut up into small pieces by specially designed knives and carried into large cast-iron cells known as diffusers. Here they are treated by the diffusion process, as described later on in the chapter on manufacture of sugar from beets.

The juice, as it runs from the mill, is strained and limed and passes into the clarifiers, where the temperature is raised and the lighter impurities come to the surface

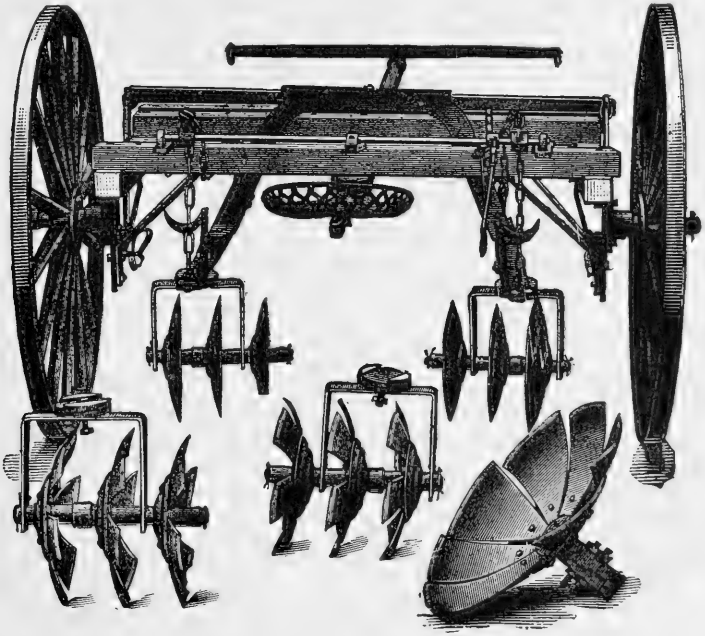
and are skimmed off, while the heavier go to the bottom, and the clear juice is drawn off and sent to the boiling-down apparatus, double or triple effect. Here it is concentrated into a syrup, again treated to remove impurities, and then goes to the vacuum pan, where it is boiled to grain. The contents of the pan are then sent to the centrifugal machines, which separate the sugar from the molasses, and the barreling of the sugar completes the cycle of operations.



CANE STUBBLE DIGGER.

A second crop of crystals, of lower grade, is made from this molasses, and its molasses is the final by-product. The scums and settlings are passed through filter presses and quite a quantity of sugar recovered from them.

A sugarhouse turning out one ton of sugar per hour will require about 90 men, skilled and unskilled, from the chemist to the trash boy.



CULTIVATOR FOR CANE.

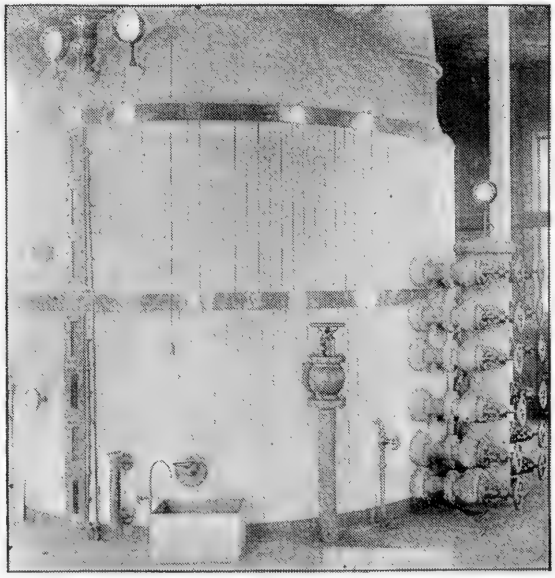
QUALITY AND GRADE OF PRODUCT.

The product from such a modern sugarhouse is called "centrifugal" sugar, as contrasted with sugar made by the old-fashioned, open-kettle process, which is known as

"open-kettle" sugar. By the latter system, the juice of the cane is evaporated in four large iron kettles arranged in a line. The juice, after being sulphurized, is drawn into the first or Grand kettle, where it is limed, heated and the scums removed. It is then drawn into the second or Flambeau kettle, where it is brushed and cleaned, then passed to the third or Syrup kettle, where it is further brushed, thence passed into the Batterie, where it is reduced to the granulating point. It is then dipped out into coolers and run into large strainers, which allow the molasses to drain off. The resulting "open-kettle" sugar is then ready for the refinery, and constitutes what was formerly known as brown sugar, but very little of it now reaches the market until after it is refined.

The commercial grades of these two kinds of sugar: Open-kettle sugars are raw and unrefined, the name of each grade, beginning with the lightest color, is as follows: —Choice, Strict Prime, Prime, Fully Fair, Good Fair, Fair, Good Common, Common, and Inferior.

The best grades of centrifugal sugars are almost as good in quality, appearance and saccharine strength as the best grades of refined sugar resulting from the refining processes employed in the very extensive refineries, most of which are operated by the "sugar trust." The best grade of centrifugal sugar is known as Plantation Granulated, and the other commercial grades are graded according to appearance, color, etc, as follows: Plantation Granulated, Off Granulated, Choice White, Off White, Gray White, Confectioners' Yellow, Choice Yellow, Prime Yellow, Off Yellow, Seconds.



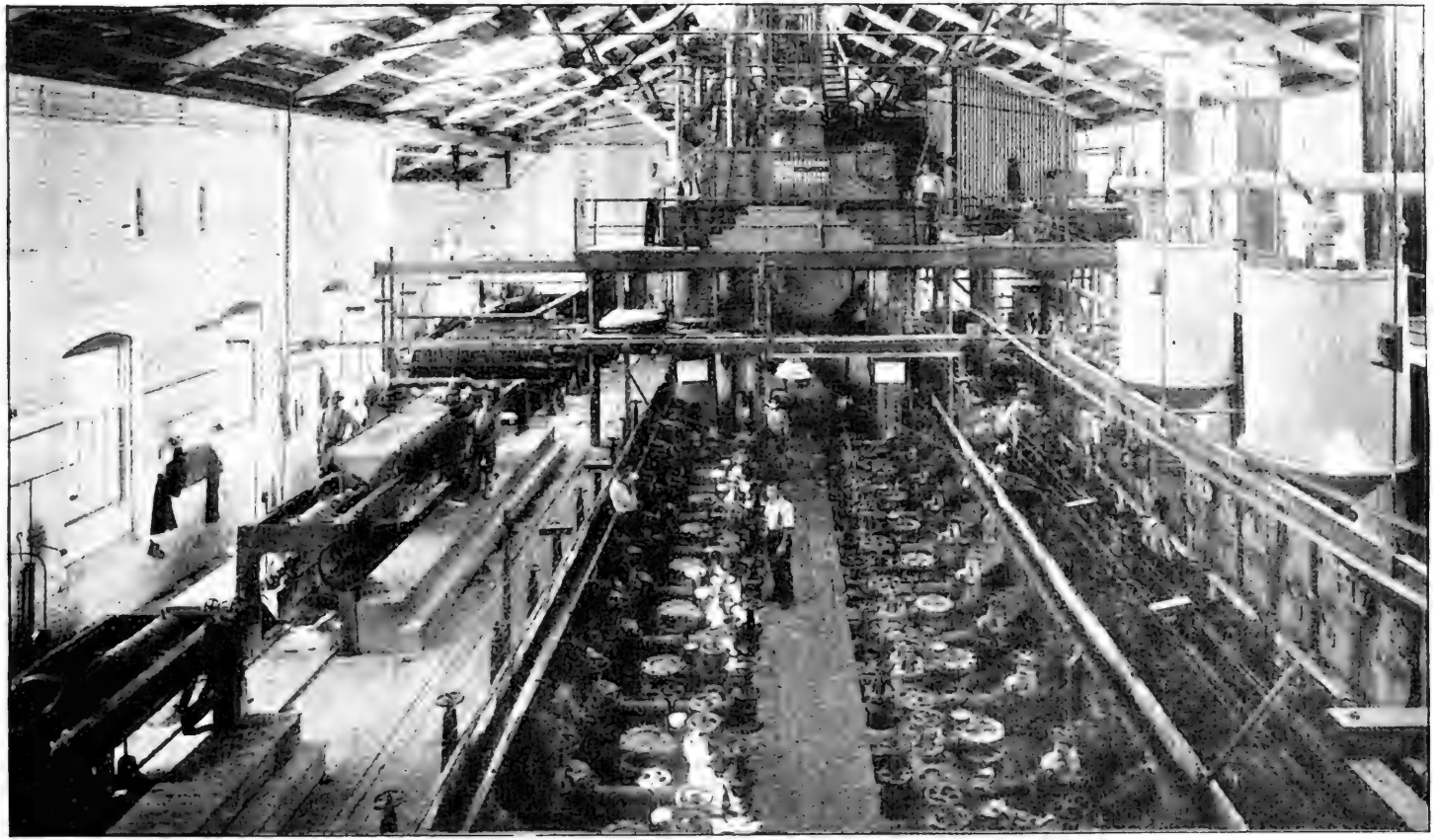
VACUUM PAN,
At the Lehi, Utah, beet sugar factory.

PART THREE.

THE BEET SUGAR INDUSTRY.

Embodying the actual results of all American beet sugar factories, the methods of the most successful practical beet growers in all parts of America, and the lessons acquired by the scientific work of the United States Department of Agriculture (Dr. Harvey W. Wiley, Chief of Division of Chemistry), and of the various State agricultural experiment stations.

BY HERBERT MYRICK.



Filter presses.

In foreground, diffusion battery for extracting juice from sliced beets; at rear, scales for weighing beets, one ton at a time.

Carbonation tanks for treating beet juice with lime and carbonic acid gas.

HOW BEET SUGAR IS MADE IN MODERN FACTORIES.—AT CHINO, CALIFORNIA.

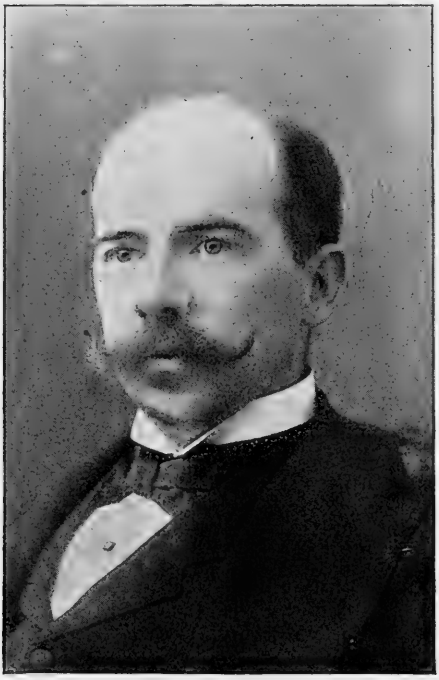
PART THREE.

THE BEET SUGAR INDUSTRY.

CHAPTER I.

WHAT HAS BEEN ACCOMPLISHED IN AMERICA.

The first efforts toward producing sugar from the beet in this country were made near Philadelphia in 1830, without success. Eight years afterward, David L. Child made a crude attempt at Northampton, Mass, the beets averaging 6 per cent. of sugar. In 1863 the Gennert Brothers, from Germany, established a factory at Chatsworth, Illinois, a location illy chosen, it is said, in soil and climate. After struggling for several years, the factory was removed to Freeport, Ill, and later to Black Hawk, Sauk county, Wis, where it was started as a co-operative enterprise. From Black Hawk a portion of the machinery, at least, was removed to California. In all of the latter instances, there was more or less inefficiency in factory management, but the chief difficulty was the lack of interest on the part of farmers, and their failure to furnish sufficient beets. The quality of the beets was also very inferior. Even in California's early days, it was several years before they learned the proper stage of maturity at which to harvest the crop. Only an elaborate account of all these early efforts could give an insight into the trials and disappointments they involved, but the lessons of this bitter and costly experience have been made the most of, and paved the way for the successes of the past half-dozen years. We should not forget to honor the pioneers in this industry. About 1871 Messrs Bonesteel & Otto erected a small factory at Fond du Lac, which, after making some sugar, was dismantled and



FOUNDER OF AMERICA'S BEET-SUGAR INDUSTRY.

This is not too much to say of Mr Henry T. Oxnard, president of the beet-sugar companies operating factories at Norfolk, Grand Island and Chino. He organized the American Beet Sugar Manufacturers' Association, and has been the head and front of the development of the beet-sugar industry in the United States as a commercial enterprise. See pages 34-35.

the machinery removed to California. Late in the '70's, beet-sugar factories were established at Portland, Me, Franklin, Mass, one in New Jersey, and another in Delaware. In California, the Alvarado plant was established in 1870, and one at Sacramento in 1873, and one a distance below that city at Istleton in 1874 or '75. The two latter soon failed, and an attempt at Los Angeles, along in 1878-9, never amounted to anything.

A TYPICAL SUGAR BEET.

This beet was selected for illustration herein from a lot of 57 tons of "mother beets" chosen for seed-growing purposes by the Utah Sugar Co. The above engraving is just half size. The original beet was 13 inches long, exclusive of an inch or two broken off the tip. It weighed 28 ounces and contained 17 % sugar, of 84 purity. For seed growing, the top is left as shown, but for the factory, the butts of stems and woody matter forming the oval top are cut off square and clean.

ALL THESE EARLY ATTEMPTS FAILED

for the reasons stated on Page 12 and also because at that time other crops were so much more profitable that farmers would not grow beets, in the culture of which they were wholly ignorant. The then high-priced lands of the east, with the expensive manuring and labor involved in the crop, did not make sugar beets profitable with farmers. The factories, in the east at least, were not located so as to secure a large supply of beets from the immediate neighborhood, and high freights cut down the farmers' returns. The factories were comparatively small, and with a limited supply of beets of uneven or inferior quality, their operating expenses left no margin of profit.

Later, attempts were made to establish the industry in Canada, and a factory was established at Berthierville, Quebec, and another at Farnham, Quebec, but the French Canadians did not have sufficient enterprise to grow the beets, and with mismanagement of the factory, the industry languished in spite of a small subsidy from government. The Berthierville plant was removed to Eddy, New Mexico, in 1896, and the Farnham outfit to Rome, New York, in 1897. The Dominion government encouraged the industry by a direct subsidy of (we believe) one cent per lb, but it was not continued long enough to overcome the indisposition of farmers to raise the beets, although the Farnham enterprise got $44,000 from this source in the years 1892-3, and Berthierville $41,000 in the years '95-6.

AN EXCEPTION--HONOR TO WHOM HONOR IS DUE.

The factory at Alvarado, California, started in 1870, is the first sugar factory which

THE HISTORIC BEET SUGAR FACTORY AT ALVARADO, CALIFORNIA.

This was the first successful enterprise of the kind in America, and has been operated for nearly 25 years.

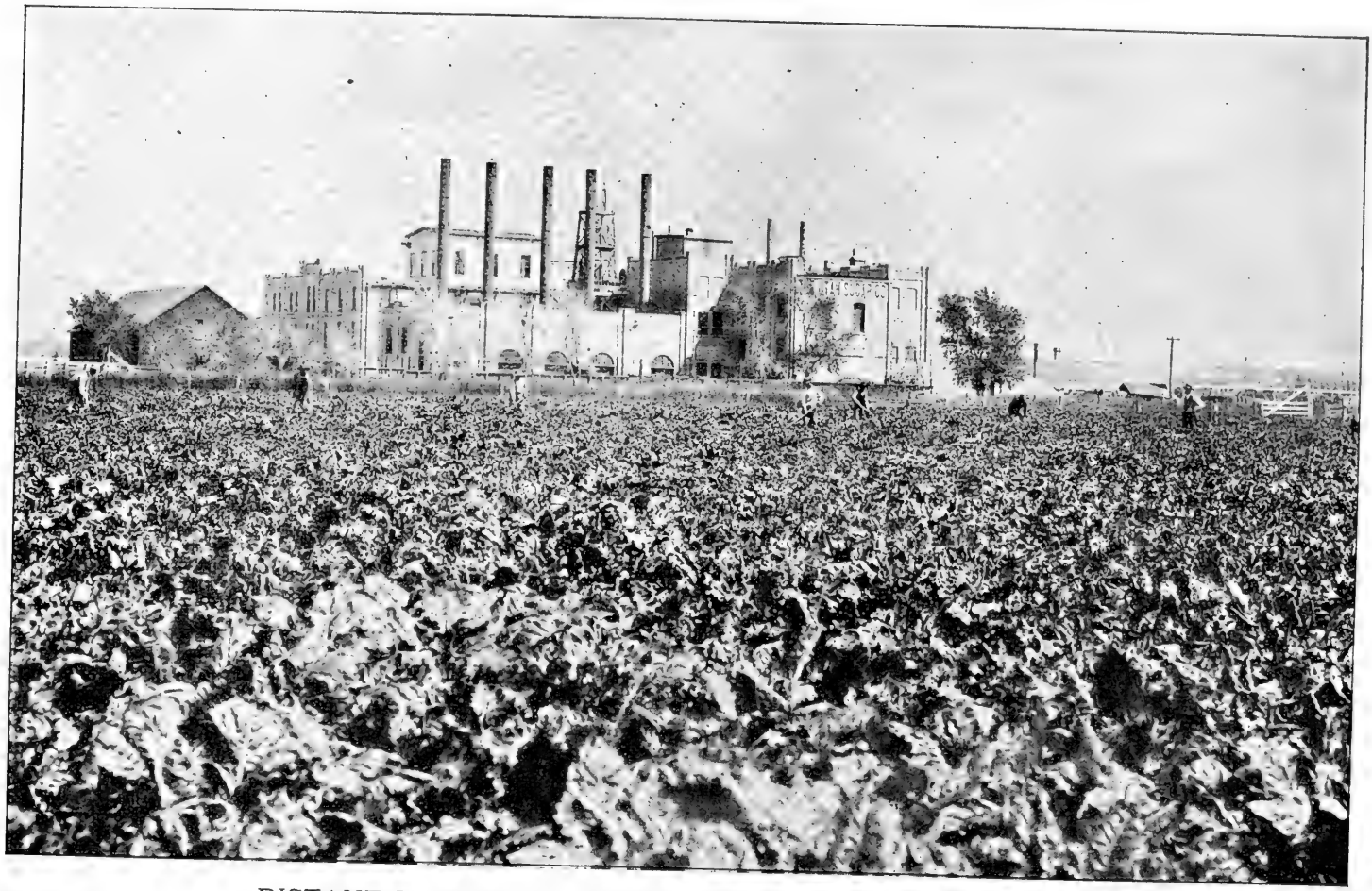
has continued its existence to the present time. Its machinery came originally from the failures in Illinois and Wisconsin. The Alvarado enterprise struggled along for years, while the farmers were learning how to grow beets, and while the quality of beets was being improved, and in the face of the competition of free sugar from Hawaii. Too much credit cannot be extended to E. H. Dyer, and his brother, Edward F. Dyer and others, for their persistent work at Alvarado.

Credit is also due Dr C. A. Goessman, an expert who came over from Germany in 1857, as chemist to a sugar refinery at Philadelphia and became chemist to the Massachusetts agricultural college at Amherst ten years later. With funds furnished by that institution, Goessman conducted the first really scientific work in sugar-beet culture in this country, 1873-6. This was followed by work with sorghum, 1876-9, which he had been studying since his first report upon it to the New York state agricultural society in 1861. Goessman's results demonstrated the practicability of the sugar beet, and also showed the comparative weakness of sorghum as a commercial sugar plant. Had his teachings been followed, the present condition of our American beet-sugar industry might have been reached ten or twenty years earlier.

Liberal recognition is also due Lewis S. Ware, M E, editor of the Sugar Beet, also Henry Carey Baird & Co, its publishers, by whom that journal has been conducted for 17 years, largely as a labor of love and as a patriotic duty in aid of this great industry that is now on the threshold of a mighty growth.

Dr H. W. Wiley, chief of the division of chemistry, United States department of agriculture, when in charge of the sorghum work, tried to make that enterprise a success if possible, but as early as 1884 he investigated the sugar beet in California and reported favorably upon it. In 1883, he urged that stations be established to experiment with beet, cane and sorghum, but Dr Wiley says it was not until Secretary Rusk's administration (1888-'92) that he was allowed to carry out his plans. Then the beet station was established at Schuyler, Nebraska, for sorghum at Sterling, Kansas, and for cane at Runnymede, Florida, later for all sugar plants at Union Island, California. These were all abolished by Secretary Morton, the Florida station going last in 1895. Dr Wiley's work is embraced in Bulletin 27, prepared in 1889.

While the gentlemen above named and many others not mentioned, did much in the early days of the industry to promote it, the real impetus given to the beet sugar industry as a practical commercial enterprise in the United States dates from the time the Oxnards took it up late in the '80's. After large experience in the cane sugar and sugar refining interests in the United States, Mr Henry T. Oxnard made a special study of beet sugar abroad, and became convinced of its possibilities here. With characteristic energy, enthusiasm and ability, Mr Oxnard spared neither labor nor money in conducting a grand campaign of education, in the course of which he has expended largely of his private fortune. He was also the organizer of the American beet sugar manufacturers' association in 1891, and as its president has served without salary and mainly at his own expense. Mr Henry T. Oxnard has backed up his faith with immense investments in sugar factories, by giving away many tons of beet seed, and is to-day the recognized head of the industry in the United States. With the aid of his brother James G. Oxnard (a sugar engineer of large practical experience), James G. Hamilton and others, the favorable legislation



DISTANT VIEW OF THE UTAH SUGAR FACTORY AT LEHI,

A few miles south of Salt Lake City. A large field of beets in the foreground, nearly ready to "lay by." Snow-capped mountains in the rear. Equipped exclusively with American-made machinery.

of 1890 was obtained, and the great beet-sugar factories at Chino, Grand Island and Norfolk were built by different companies, of all of which Mr Henry T. Oxnard is president. During 1896-7 he has been indefatigable in political circles and at Washington to secure a fair chance for the industry against foreign competition. He has now organized a construction company through which to give the full benefit of his experience, and of the body of trained experts associated with him, to those who contemplate building or operating beet-sugar factories.

RECENT DEVELOPMENT.

Results at Alvarado finally attracted the attention of Claus Spreckels, the Hawaiian cane-sugar king. Thoroughly informed upon the beet-sugar industry in his native country (Germany), Mr Spreckels realized three things: (1) That it was only a question of time before the United States would abrogate the one-sided reciprocity treaty with Hawaii that was making him immensely wealthy; (2) that there was no reason why this country should not produce its own sugar, California offering ideal advantages; and (3) that in the battle for supremacy the beet is destined to win. With his usual keen business judgment, Mr Spreckels erected a small beet-sugar factory at Watsonville, which turned out about 1000 tons of sugar from beets grown in 1888. The plant was enlarged in time to profit by the McKinley bounty, and has gone on with uninterrupted success until it converted into sugar more than 160,000 tons of beets grown in 1896.

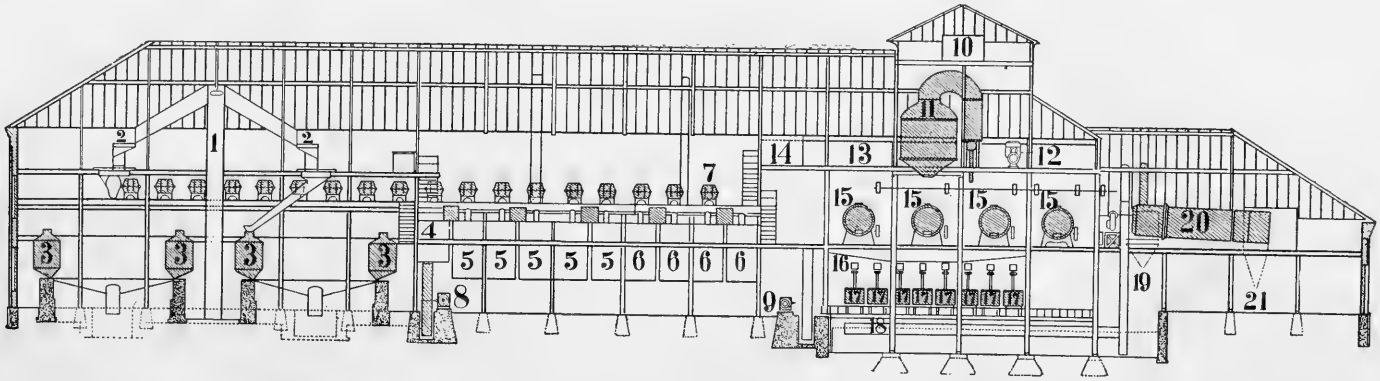
The Oxnards established the great beet-sugar factory at Chino, Cal, in time to work up the 1891 crop, and in the campaign of 1895 it handled 83,000 tons of beets. The Oxnards had the sugar factory at Grand Island, Nebraska, done in time to work up 4500 tons of beets grown in 1890, and it converted about 25,000 tons of the '96 crop of beets into sugar. The same interests built the factory at Norfolk, Nebraska, which worked 8000 tons in its first (1891) campaign, and upward of 50,000 tons in 1897.

Local capital and the characteristic enterprise of certain men prominent in the Mormon church, led to the establishment of the factory at Lehi, Utah, which handled nearly 10,000 tons of beets in its first campaign (1891), and nearly 45,000 tons of the 1896 crop. O. K. Lapham also established a small plant at Staunton, Virginia, that demonstrated the practicability of the industry, but was burned in 1894. The factory at Eddy, New Mexico, was got in operation in time to work up a few thousand tons of the '96 crop, and the same can be said of the new plant at Menomonee Falls, Wis.

THE RECORD IN BRIEF.

Such is an outline of the beet-sugar industry in America to the opening of 1897. The bounty of two cents per pound for fifteen years offered by the McKinley tariff, Aug 6, 1890, gave a great stimulus to an industry which years of extensive and costly experimenting had shown could be developed in this country. But before much could be done, progress was arrested by the Wilson tariff, Aug 28, 1894, removing the bounty and substituting a duty of only 40 per cent ad valorem, with constantly decreasing prices, due to the unfair competition of European export-bounty-fostered sugars.

As usual, it took the farmers several years to learn how to grow beets, and it was not until 1896 that these factories were supplied with all the beets they could possi-



ARRANGEMENT OF THE LATEST IMPROVED BEET SUGAR FACTORY IN AMERICA.

The Los Alamitos factory, near Los Angeles, California, is now (1897) being erected, and will be ready to work up this year's crop, as described later on. Key to numbers in above sectional view: **1.** Beet elevator. **2.** Beet cutter—The beets are cut into ribbands by ten revolving, V-shaped knives. The sliced beets, called cossetts, are delivered by a revolving spout into (**3**) diffusion batteries, each consisting of 14 cells. Each cell holds 2½ tons of cossetts. Hot water is forced from one cell to the other and after passing through nine cells the water has become of the required density, and is then forced to the measuring apparatus. The cossetts are discharged from the bottom into the hopper-like foundation, and pass to the pulp press through the opening shown on the far side. **4.** Receiving tank. **5.** First carbonators—The juice from the measuring apparatus is here treated with milk-of-lime, and then precipitated by carbonic acid gas. **6.** Second carbonators, practically the same process as in the first, but the alkalinity is brought lower. **7.** Filter presses—Juice is here forced through a finely woven burlap, which collects the impurities precipitated by the carbonic acid gas. **8.** Engine that drives beet department. **9.** Engine that drives sugar department. **10.** Tank to supply the diffusion battery. **11.** Strike pan—The concentrated juice from the evaporators is boiled under a vacuum, to a grain, and is then called massecuite. **12.** Air pump to remove the air and gases from the strike pan. **13.** Tank to hold concentrated juices, preparatory to being worked in the strike pan. **14.** Water tank. **15.** Crystallizers—Apparatus by which a larger yield of sugar is obtained than by the common method of working the massecuite direct from the pan; consists of thoroughly and uniformly agitating the mass of massecuite under treatment, and a delicate and timely control of the temperature. **16.** Mixer—Device to keep the massecuite from solidifying while waiting to be treated by the (**17**) centrifugals. These are rapidly revolving perforated drums, by which the syrup is thrown through the perforations and the sugar crystals are retained. The conveyor (**18**) collects the sugar from the centrifugals and delivers it into the (**19**) elevator. Thence it passes to the (**20**) sugar dryer, and then to the (**21**) barrel packers, when the refined granulated white sugar is ready for market. The designing and construction of the buildings and machinery was done by E. H. Dyer & Co., who also furnish the entire equipment, the machinery being made for them by the Kilby Manufacturing Co., so that the entire enterprise is American throughout.

bly work into sugar. This season was a disappointment at Chino, where the expected crop was considerably curtailed by drouth. At Lehi, on the other hand, too many beets were grown—the factory could hardly work them all. We are under obligations to Willett & Gray for the following.

SUMMARY OF BEET SUGAR PRODUCTION IN THE UNITED STATES:

[In tons of 2240 pounds.]

1830,	A few hundred pounds	1884,	953 tons
1831-7,	None	1885,	600 tons
1838-9,	1,300 lbs	1886,	800 tons
1839 62,	None	1887,	255 tons
1863-71,	300—500 tons per annum	1888,	1,910 tons
1872,	500 tons	1889,	2,600 tons
1873,	700 tons	1890,	2,800 tons
1874-7,	Under 100 tons per annum	1891,	5,359 tons
1878,	200 tons	1892,	12,091 tons
1879,	1,200 tons	1893,	20,453 tons
1880,	500 tons	1894,	20,443 tons
1881-2,	Less than 500 tons	1895,	30,000 tons
1883,	535 tons	1896,	40,000 tons

WHAT OF THE FUTURE?

Wherever factories have been established, farmers are now eager to raise beets for them at $4 to $5 per ton. Offers have been made to grow beets for the older factories in 1897 far in excess of their capacity. Watsonville could not accept half the acreage offered. In such cases, the factories contract only with those growers who have shown the most interest and the ability to furnish beets of the best quality.

Mr Spreckels has under construction at Salinas City, California, what is destined to be the largest single beet sugar factory in the world, with a capacity of over 300,000 tons of beets during a campaign of about 100 days, that will be ready for the 1898 crop, and will require 25,000 acres of beets for its supply. At Alamitos, California, a new factory will be ready for 1897 with a capacity of 350 tons of beets per day. The first New York Beet Sugar company hopes to have the machinery from the plant at Farnham in operation at Rome, New York, in time to handle 30,000 tons of the 1897 crop.

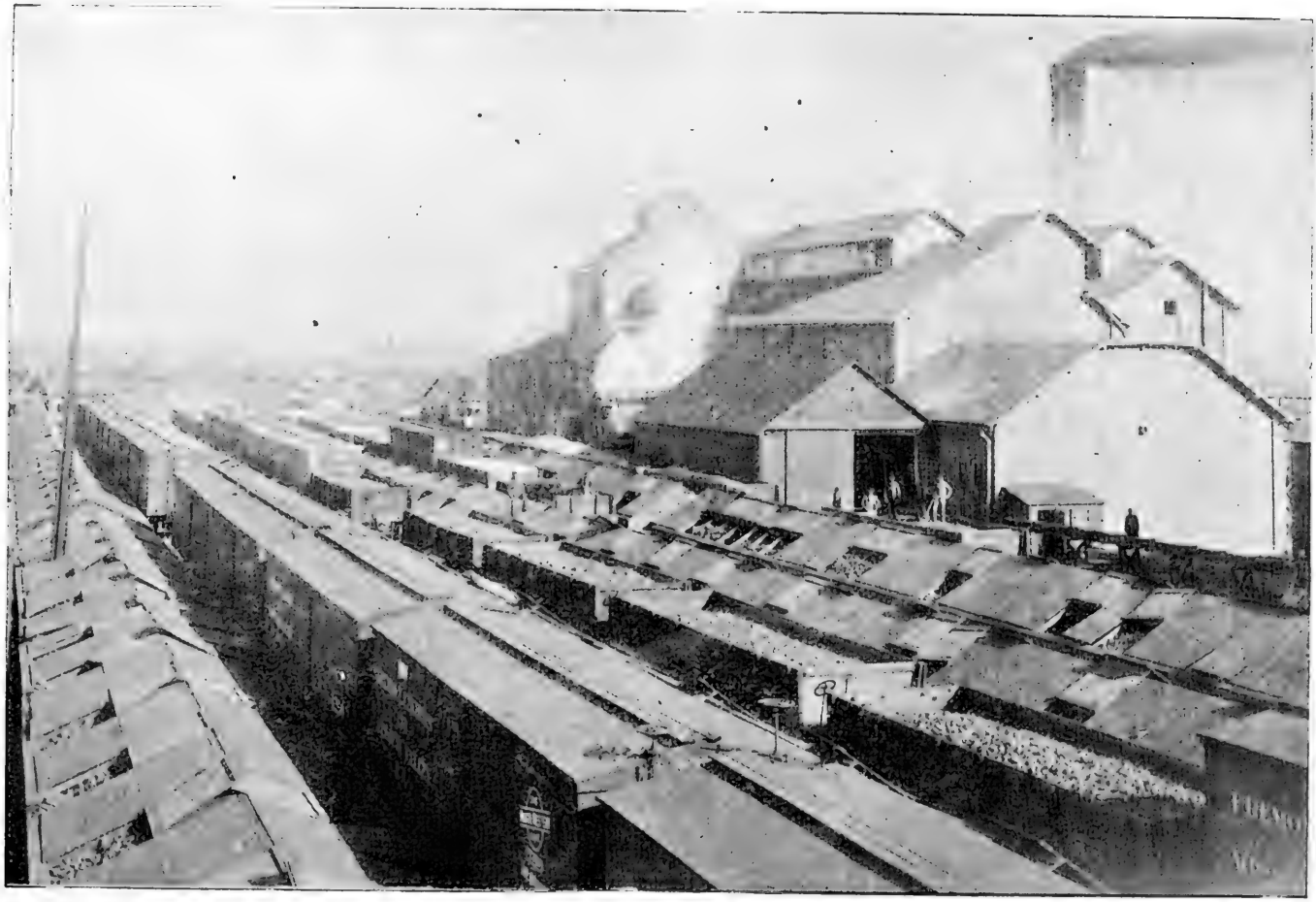
Several of the existing factories propose to enlarge. There are a number of other factory enterprises that are more or less organized. About 1000 communities in the cane and beet sugar belts are anxious to secure beet-sugar factories or cane-sugar houses. There is no question about the prompt and extensive development of the industry, if congress extends to it satisfactory assurances that the American market will be preserved for the American sugar producers. Without this, the business will stop right where it is.

ELEMENTARY PRINCIPLES.

Before proceeding to give details of just how the foregoing has been accomplished and a full discussion of what has been learned from all past experience that may guide us in the future, a few elementary points should be understood.

TECHNICAL TERMS EXPLAINED.

Prof W. A. Henry covers this point very clearly in these words: What is meant by "per cent of sugar in the juice" and by co-efficient of purity? A hundred pounds of sugar beets contain about 95 pounds of juice. This juice not only contains sugar



DELIVERING BEETS BY RAIL TO THE SUGAR FACTORY AT NORFOLK, NEBRASKA.

but various other substances, largely mineral matter, which are a great hindrance, causing serious losses of sugar during the manufacture. A hundred pounds of average beet juice will carry about 15 pounds of solid matter, of which twelve pounds may be sugar, and three pounds matter not sugar. If we divide the number of pounds of sugar (12) by the total pounds of solid matter (15), we get .80, which sum is called the co-efficient of purity; that is, beet juice with 15 parts solids, 12 of which are sugar, is said to have a co-efficient of purity of 80. If the sample of juice contains 16 parts solid matter and 12 parts sugar, as before, then the co-efficient of purity is only 75.

When reducing the beet juice to make sugar, each pound of foreign matter, not sugar, keeps at least one pound of sugar from crystallizing. This true, we see at once that the manufacturer desires beet roots not only carrying much sugar but also with a high co-efficient of purity. Immature beets, those grown on soils rich in vegetable matter or fertilized with fresh barnyard manure, those grown on land recently cleared from the forest, or on drained swamp lands, are all liable to carry a great deal of solid matter not sugar in the juice, and consequently are quite unsatisfactory to the sugar manufacturer. Large beets are likewise always poor in sugar. The leaf stems of the beet, as well as the crown of the beet root itself, also carry much foreign matter. In practice, the manufacturer recovers about 7 out of every 10 pounds of sugar contained in the beet root.

It should be added that the apparent co-efficient of purity of the juice is frequently misleading, since it takes no account of the nature of the non-sugars present. The real purity of the beet is also to be distinguished from the apparent purity of the juice. The real purity of the beet is obtained by dividing the percentage of sugar in the beet by the total solid matter therein; the apparent purity of the juice by dividing the percentage of sugar therein by the apparent percentage of solids as indicated by the Brix spindle.

QUALITY OF THE BEET SUGAR.

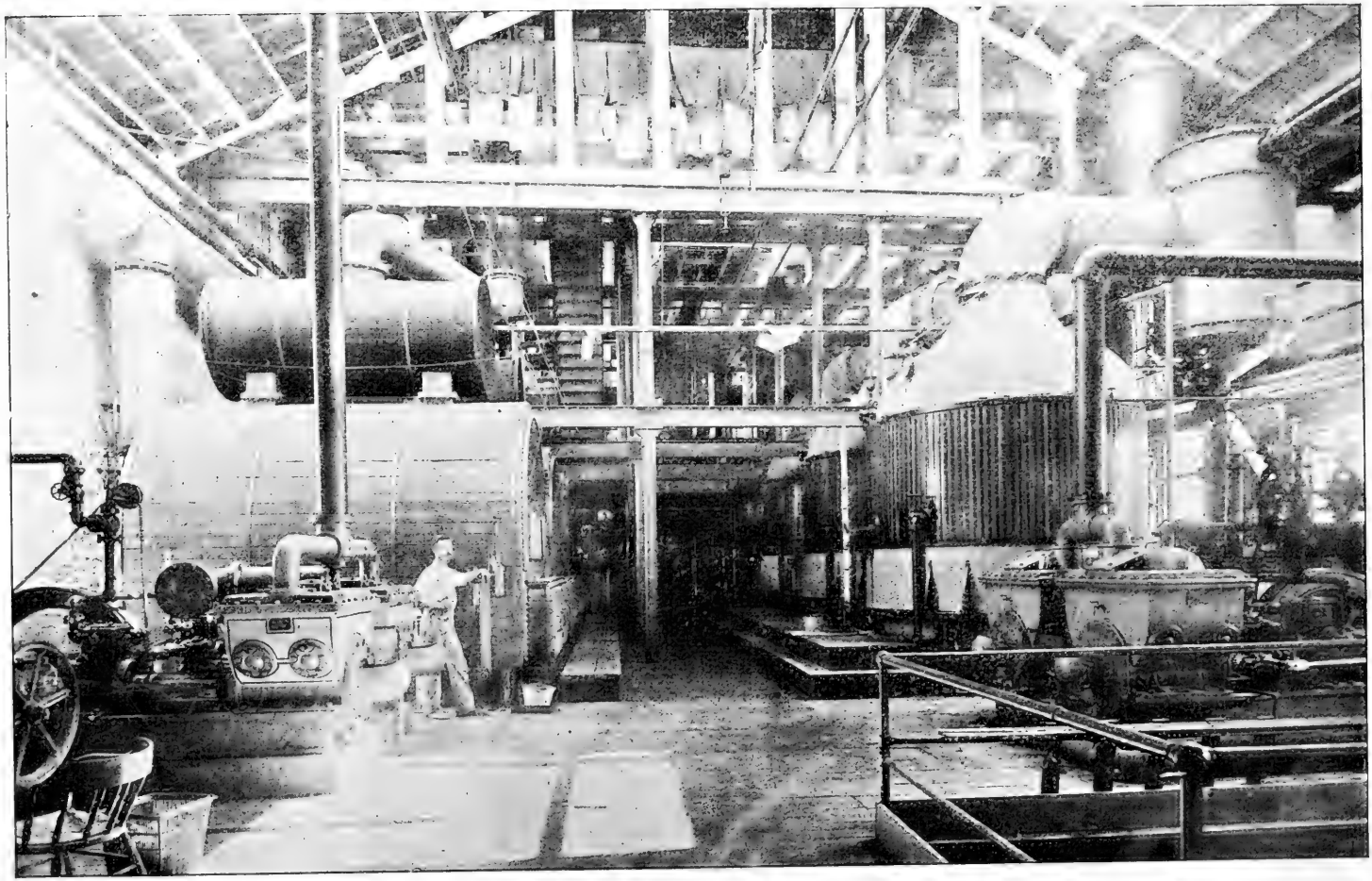
Whenever the subject of beet sugar is brought forward the first inquiry usually made is, "Is beet sugar white like other sugar and does it not have a peculiar taste?" In its very beginning, when struggling for recognition in Europe, the beet industry was handicapped by the claim that its sugar was not equal in quality with that yielded by the cane plant of the tropics. England did not wish to recognize any competitor with the cane sugar of her dependencies. In brief, to answer the questions asked above, the refined sugar from the beet root equals in all particulars that yielded by the cane plant. Enormous quantities of beet sugar are now being shipped to this country from Europe, mainly Germany, and the chances are more than even that the persons who question the purity and flavor of beet sugar are using it daily in their tea and coffee.

HOW BEET SUGAR IS MADE.

The large illustration on Page 30 gives an admirable view of the interior of the Chino beet-sugar factory, which will help to make clear this description of the process of manufacture. First, the beets are brought in by the farmers and deposited in large sheds with V-shaped bottoms, which are connected with the factory by means

of channels, through which a moderate flow of water carries the beets into the first washing machine. By means of a spiral, the beets are tumbled about, washed and carried on until they drop into an elevator, which carries them to the top of the building, where they pass through an automatic weigher and are sliced in such a manner as to open up the pores of the beet as far as possible. The sugar beet is very similar to the honeycomb, and in its little cells is secreted the sweet matter, so that in slicing, it is desirable to open up as many of these little cells as possible. Hence the necessity of having the knives sharp, so that the cells may not be ruptured, but clean cut. As these slices come from under the cutter, they are put in what is known as a diffusion battery, shown in the center of the foreground of illustration on Page 30. In this battery, the sugar is extracted by soaking the sliced beets in water. Warm water is turned into the contents of a large iron jar holding several tons of sliced beets. This water circulates through the mass of cossettes (the name given to the slices of beets) and passes out through the bottom by means of a pipe which enters the top of Jar No 2, the water being forced along by pressure.

From one battery to another, this liquid passes along until it has gone through 14 cells or jars, when it is shown that sufficient water has passed through Jar No 1. The water is now turned off and No 2 becomes No 1 and No 1 is emptied of its cossettes and refilled, becoming No 14, and so the circle is continued all day and all night, procuring in this way all the sugar in the cossettes in liquid form, which now has the color of vinegar. This liquid is now taken to a measuring tank near by from which it goes to a mixer, where it is mixed with lime and then put into a huge tank for carbonation, in which the lime and all foreign matter it contains is rendered insoluble by means of carbonic acid gas forced through the bottom of the carbonation tank. Then the mixture comes through the filter press room where, by means of an elaborate series of frames, it is filtered, and becomes transparent. The process of mixing, carbonating and filtering is then repeated for the second time. This finished, the syrup is treated with sulphur fumes and then passes into the quadruple effect, which is four large boilers in which the water contained in the syrup is evaporated, when we have what is called "thick juice." This syrup is boiled in the vacuum pan, and now becomes raw sugar, and is then run into the centrifugals and made into white sugar. The sugar is now damp, like wet snow, and by means of a granulator, it is dried, and through different sieves is separated into the finer or coarser-grained sugar, ready for the market.



DOUBLE SET QUADRUPLE EFFECT EVAPORATORS, CHINO.

CHAPTER II.

HOW THE INDUSTRY HAS GROWN IN EACH STATE.

CALIFORNIA.

The Golden State is on the eve of an enormous development of her beet-sugar industry. The remarkable success of this industry in recent years has stimulated both capitalists and farmers to push this new industry to the utmost in case the American market is reserved for American sugar. Experiments in many parts of the state have been conducted extensively during the past six years. In many of these cases, the beets have been raised on a large scale and shipped to existing factories, some being hauled long distances. In other cases, the crop has been used as feed for stock while the farmers were learning how to raise the crop, and demonstrating the adaptability of the sugar beet to their peculiar soil by having the beets analyzed at the state experiment station. It is now evident that there are hundreds of square miles of the richest land in the world available for sugar-beet culture in the Golden State.

PRESIDENT ALLEN.

R. M. Allen, president of the American sugar growers' society, is also president of the Nebraska state sugar growers' society and one of the largest growers of sugar beets in the country, having grown 500 acres of beets annually for the past six years. He is also a large cattle feeder and is profoundly impressed with the vast possibilities of the beet sugar industry and of the great value in cattle feeding of the beet pulp from the factory and of the beet tops.

The factory of the Alameda sugar company, at Alvarado, will probably be enlarged this year. During the campaign with the 1896 crop, it has worked up about 55,000 tons of beets. Their sugar content varied from 12 to 18 per cent, with from 70 to 88 per cent co-efficient of purity, averaging over 15 per cent of sugar and 81 purity. We give on Page 33 an excellent photo-engraving of this historical pioneer factory.

In the 1895 campaign Alvarado worked 27,385 tons of beets into 5,400,000 lbs of sugar, the beets averaging 13 per cent of sugar.

MR SPRECKELS' ENTERPRISE AT WATSONVILLE

in Santa Cruz county, near the coast, about 75 miles south of San Francisco, and 25 miles north of Monterey, has the credit of standing at the head of the sugar industry

in America, working up in a single season the largest quantity of beets, and turning out the largest quantity of sugar ever made by one factory in this country. As high as 1400 tons of beets have been crushed by the factory in one day of 24 hours, also the American record. The campaign of 1896 began in September and concluded on January 29, beets being delivered by the farmers up to Jan 23. There were 154,936 tons of beets delivered to the factory by rail and wagon, from which 19,528 tons of sugar were made during the campaign of 171 days, the factory running 3446 hours—the longest run on record in this or any other country. This plant does not refine its product, the raw sugar being shipped to the Spreckels' refinery at San Francisco, which accounts in part for the large capacity of this factory.

It is not likely that this phenomenal record will soon be duplicated by this or any other factory. The conditions were about as near perfect as could be, both in field and mill. The phenomenal crop of 1894 was beaten by about 10,000 tons by the crop of 1896, but the quality was much higher, as 7000 more tons of sugar were obtained the past season than in the 1894-5 campaign.

The 155,000 tons of beets were grown on about 11,017 acres, yielding an average of 14 tons of beets, and 3,545 pounds of raw sugar per acre. Some fields gave as high as 25 tons per acre, and small plots of a few acres ran up to 30 tons, while several tracts of 100 acres or more averaged 18 tons per acre. Fully 12,000 acres have been contracted for the '97 campaign, indicating a probable crop of 150,000 tons.

In the campaign of 1895, the Watsonville factory ran 2063 hours, sliced 77,145 tons of beets or an average of 900 tons per day of 24 hours. From these beets 10,945 tons of sugar were manufactured. The beets were produced on 7244 acres, which averaged nearly 11 tons of beets and 1½ tons of sugar per acre. This is a smaller yield than in previous years, because of extensive rainfall during the harvest period.

The Watsonville factory pays $4 per ton for all beets, or a total paid farmers for the '96 crop of nearly $650,000 compared to $300,000 for the crop of the previous year. Since its humble beginning upon the crop of 1888, this concern has paid the farmers about $2,500,000 for beets—a new crop that but for this factory would not have been grown. More than half a million has been paid for labor in this factory. In brief, this enterprise, in a little more than eight years, has distributed some $3,000,000 among the farmers and laborers of this vicinity—money that otherwise would have gone out of the country to pay for imported sugar. This money and the industries its circulation has created, have built up a remarkably prosperous community, where farmers were prosperous and money was easy all through the hard times of 1893-6. Whole pages could be filled with the particulars of the beneficent results of the industry, especially in view of the fact that but for it these farmer would have been obliged to raise grain or fruits at little or no profit. Many of them have paid off their mortgages and acquired a snug little competence besides from the beet crop. Says the local paper, the Pajaronain of Jan 21, 1897: "The beet payday last week was a giant and twenty-dollar pieces crowded each other in Watsonville. There was about as much money paid out here that payday as the railroad company pays out monthly at its big shop center, Sacramento; and the next payday will be about as large."

EXPERIENCE IN SOUTHERN CALIFORNIA.

The enterprise at Chino in San Bernardino county in Southern California, is in

PARTIAL VIEW OF THE MODEL BEET SUGAR FACTORY AT CHINO, CALIFORNIA.

many respects typical of what the sugar industry can do for a community. A few years ago this was a vast ranch, which Richard Gird had purchased and conducted as a cattle and horse-breeding establishment, on the liberal scale characteristic of California's early days. With the decline in live stock, however, Mr Gird recognized the necessity of devoting his property to the production of some crop that could be utilized at a profit in the vicinity. Instead of going into citrus fruits or other specialties already established in that region but in which he feared overproduction, he looked into the beet-sugar industry, raised beets for a number of years on various soils, determined their sugar content, and in due time was able to demonstrate that on this spot could be raised the largest yields per acre of beets richest in sugar. All this involved a vast amount of original and costly work, and thus it took two or three years to find capitalists and get them sufficiently interested to put up the money needed. The outcome was the establishment by the Chino Valley Beet-Sugar Company of the immense plant illustrated in part on Pages 30, 45 and 47, in which the Oxnards are the controlling spirits.

Mr Gird had to contract to furnish the factory with at least 5000 acres of beets for several years—and this at a time when there was not another house to be seen from the homestead on the vast ranch. But with a market assured for a new, certain and profitable crop, Mr Gird at once offered liberal inducements to settlers, land was sold in small blocks on easy terms, people flocked to Chino, until it has now become a thriving community in a well-built town, surrounded by farms of from 10 to 30 acres or more, each with its comfortable home and well to-do family. All this where cattle and horses roamed the unbroken prairie previous to 1890. And so well was the enterprise conducted that when Mr Gird wished to retire in 1896, he was able to sell the balance of the ranch to an English syndicate for $2,500,000.

The factory really began operations in 1891, when less than 2000 acres of beets were grown, and the average yield was only seven tons per acre, or a total product of 13,000 tons, for which the farmers were paid about $51,000. During the season of 1895, five thousand acres in this township were devoted to beets, while the product from 2500 acres more were hauled by rail about 75 miles from the Orange county district. The factory that year converted 83,000 tons of beets into sugar, for which the farmers were paid nearly $362,000. Most of the beets are grown within two miles of the factory, the longest wagon haul being eight miles, and the shortest half a mile. Over twenty million pounds of refined sugar was actually made and sold, exclusive of a little raw sugar and all molasses, etc, or an average of 249 lbs of refined sugar obtained and sold from each ton of beets, or 2747 lbs from each acre of beets. The land about the factory is peculiarly fitted for this industry, as seed can be planted very early on the uplands, and then in succession on the lower lands. Thus the factory can begin to work up the early crop in July, and in the absence of frost can run until the latest seeding is harvested in November. All pitting and storing of beets is thus saved—a most important consideration. The season of 1896 was the dryest in 20 years, but the factory milled 63,000 tons of beets before closing down about Nov 1, part of the crop not being accepted. Chino fields furnished nearly 50,000 tons. With the usual rainfall, 80,000 tons of beets was to have been expected. The full details of the last campaign are not available at this writing, but here is a table giv-

This building at the left is for the Steffens process of refining.

Large piles of broken limestone in the foreground.

Three more large kilns under cover to the right.

LIME KILNS AT CHINO BEET SUGAR FACTORY

ing an immense amount of information about the industry and its growth.

THE RESULTS AT CHINO FOR ITS FIRST FIVE YEARS.

	1891	1892	1893	1894	1895
Acres of beets grown,	1,800	3,488	4,191	4,778	7,528
Tons of beets produced,	13,080	26,266	49,353	43,773	83,035
Average yield of beets per acre, tons,	7.26	7.50	11.7	9.16	11.03
Per cent of sugar in beets,	13	14	14	15	15
*Crude sugar per acre, lbs,	1,888	2,100	3,276	2,748	3,309
*Pure sugar per acre (80%),	1,510	1,680	2,621	2,198	2,670
Began making sugar,	Aug 20	July 13	July 31	Aug 2	July 9
Finished making sugar,	Oct 31	Oct 11	Nov 4	Oct 24	Nov 14
Days in operation,	73	91	97	85	129
Average weight of beets worked daily, tons,	179	288	509	526	644
Average weight of sugar made daily, lbs,	28,108	86,852	15,592	111,431	161,129
Total weight of sugar made, tons,	1,026	3,952	7,532	4,736	10,393
Average paid farmers per ton beets,	$3.90	4.26	4.26	4.66	4.35
Average return per acre,	$28.37	31.95	49.84	42.69	47.98

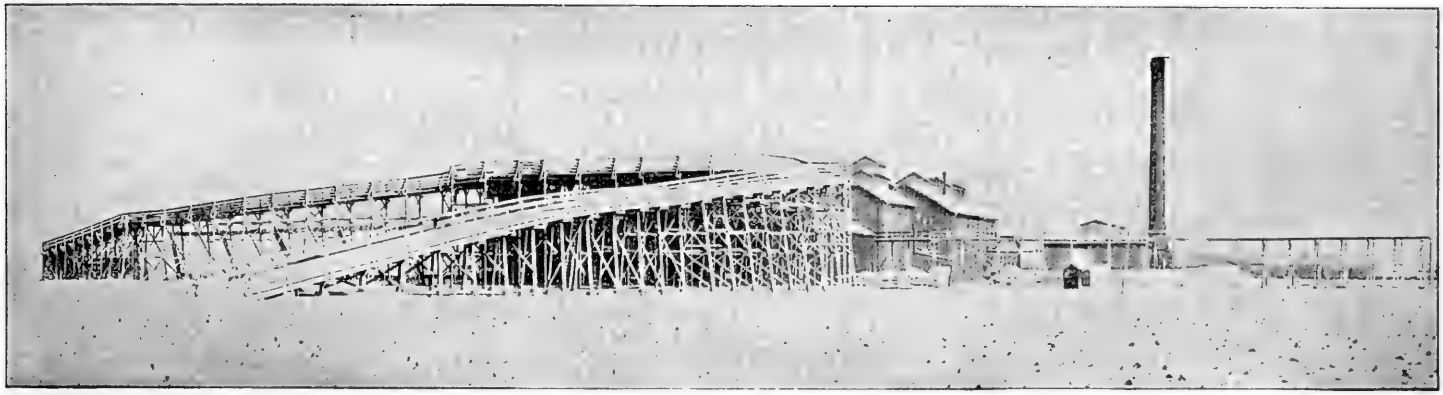
*Estimates or data figured by the author, the other facts being all furnished from the company's books. The ton is of 2000 lbs. Granulated sugar only was made in '91, raw sugar only in '92 and '93, while the product of '94 was all the best grade of refined white granulated sugar except 1009 tons (2,017,363 lbs) of raw sugar, and in '95 only 51 tons (102,286 lbs) of raws.

Among the most successful beet growers for this factory are the brothers Gustafsen, who averaged 15 to 20 tons per acre. The Dethlefsen brothers averaged 20 tons per acre on 250 acres in the comparatively poor season of 1896, and will double their area in 1897. They give their crop close personal attention, and no detail that will contribute to success is omitted. They have fully determined that there is a certain profit in intelligent beet culture, and well they may, for their net profits above all expenses and good pay for their own time and ability, have averaged over $30 per acre.

To protect their interests at the factory, planters have a strong union, which chooses its own chemist, weigher and tare man to keep tab on the beets as delivered, to see that full weight is credited on each lot, and that the deduction for tare is not too large, while the chemist's duplicate analyses are a check on the factory tests. At the annual meeting in December, 1896, of the Chino beet growers' union, numbering 106 farmers, it was reported that 48,139 tons beets were harvested and marketed. The average price per ton was $3.78, representing a total of about $180,000 paid for this season's beets. The average sugar content was placed at 14 per cent. In addition to the present membership, there are nearly 100 farmers who make a business of growing beets, and it is hoped these may also be brought into the union, in order to secure the best possible administration of the business affairs of growers. At the beginning of the season an assessment of 4c per ton was levied on all Chino beets to defray factory and office expenses of the union, including tare man and check chemist. The close of the season finds a surplus in the treasury which makes it possible to rebate 1½c per ton. Thus it cost less than 3c per ton harvested to carry on the business of the union.

The Chino factory uses oil for fuel, from 75,000 to 100,000 barrels during a campaign, which comes through pipes from the oil company, 14 miles distant, although it is hoped to get a supply near by from oil wells on the ranch. It consumed 125,000 tons of limestone in 1895, its 21 artesian wells furnished nearly 4,000,000 gallons of

Side view factory in full operation.



End view.—Late winter after close of campaign.

TWO VIEWS OF THE OXNARD PLANT AT NORFOLK, NEBRASKA.

water daily and it paid $100,000 in wages to the 350 men employed in and about the factory.

THE NEW FACTORIES IN CALIFORNIA.

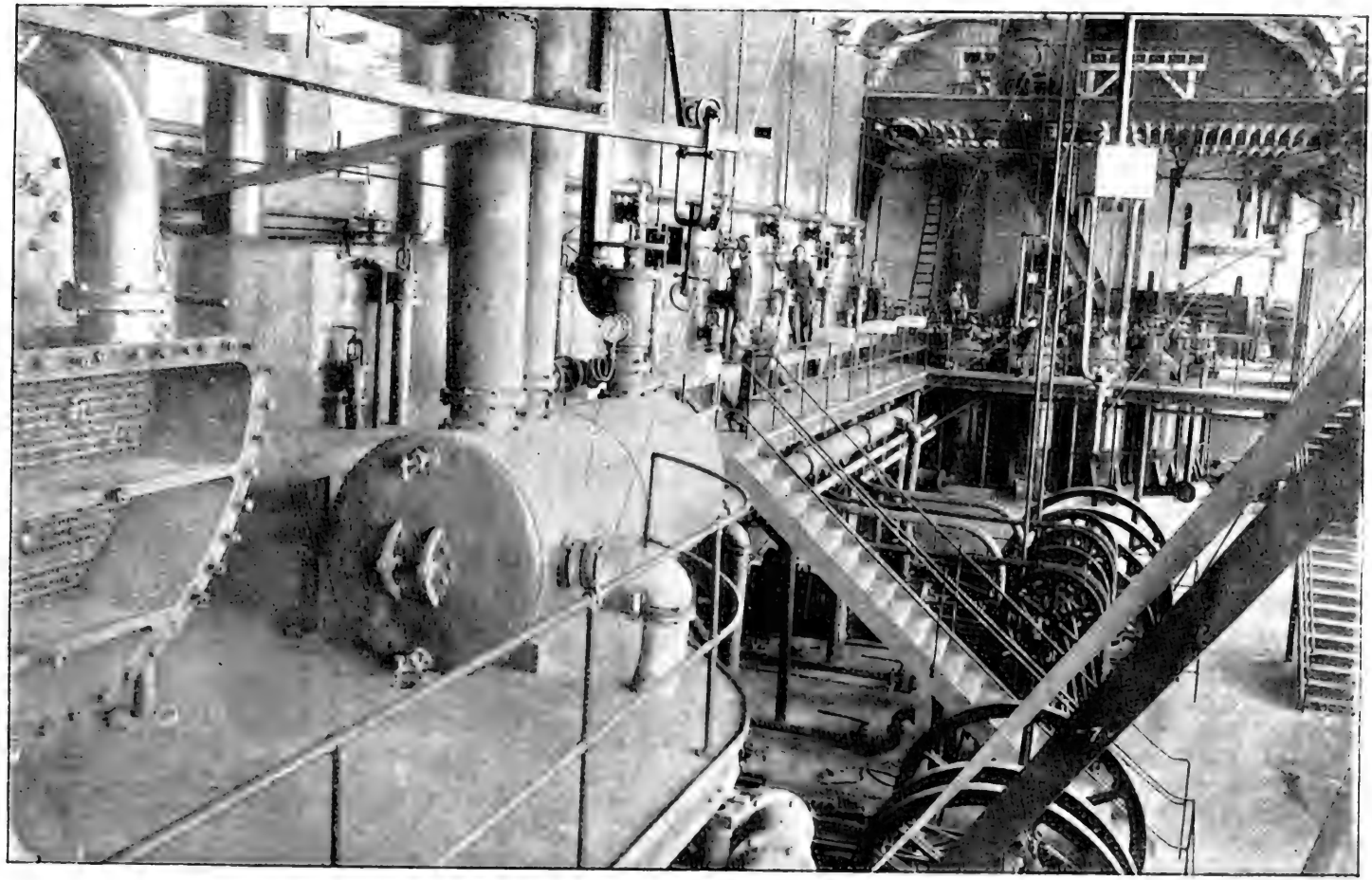
Work is going forward on Mr Spreckels' immense plant at Salinas City. While it will have a capacity of some 3000 tons of beets per day of 24 hours, it will practically consist of three sets of machinery under one roof, each of 1000 tons capacity daily. Mr Spreckels will have to pay out $12,000 a day for beets and $5000 daily for labor and other materials at the factory. According to this estimate, the daily expenses will average no less than $17,000, or nearly $2,000,000 for a campaign of under four months. It was expected at first that this immense plant would be ready for the 1897 crop and before it was decided upon, Mr Spreckels insisted on having contracts with farmers to grow 25,000 acres of beets. It now appears that delays in making the machinery are such that the plant will not be in operation until 1898. While it will use the product from 25,000 to 35,000 acres of land annually, fully 100,000 acres will be involved, in order to permit the necessary rotation of crops. Farmers in the contiguous country, however, are ready to grow 100,000 acres of beets every year if factories are put up to work them.

The Los Alamitos Sugar Co is building a large factory in the center of the Los Alamitos Rancho, which contains 6700 acres of choice sugar-beet land belonging to the Bixby Land Co, which has contracted to furnish the sugar company with its full complement of beets for a term of five years. This ranch lies about ten miles inland from the sea, near Los Angeles. The climate is perfect the year around. The soil is a deep, sandy, sub-irrigated loam, having been deposited for centuries by the overflow of the San Gabriel river, and according to the artesian-well borings, its depth exceeds 400 feet. It is believed that there is sufficient moisture in the soil to produce beets in the dryest years without irrigation. The factory is being equipped entirely with American machinery by E. H. Dyer & Co of Cleveland, Ohio, who furnish both buildings and machinery and turn them over to the sugar company when in full operation. The frame of the factory is of steel and the walls of brick and will be equipped to work off 350 tons of beets per day of the 1897 crop. The building is so large that more machinery can be added to double the present capacity at the minimum of additional expense. Great care has been given to so plan the building and machinery as to secure the utmost economy of labor and fuel. These works will handle 350 tons of beets per day with less than 100 men, and consume under fourteen per cent of lignite coal for fuel. A sectional view of the structure is given on Page 37.

Many of the sugar factory propositions in California are awaiting the action of congress. Should it be favorable, several new enterprises will be established in time to handle thousands of additional acres of beets in '98.

NEBRASKA.

The efforts to establish the beet-sugar industry in Nebraska date back about ten years, and her experience is typical of the obstacles in the way of the industry. A factory was established at Grand Island in 1889, by the Oxnards, being aided by the gift of land and a cash bonus, while the state offered a bounty of one cent per pound on the sugar, which yielded the factory $7,364 on the product of its first campaign on the crop of 1890. The law was repealed at the session of '91. Meanwhile the



INTERIOR VIEW OF A SMALL PART OF THE NORFOLK BEET SUGAR FACTORY.

Showing battery of diffusion cells arranged in a circle on main floor, in background.

Oxnards had established another factory at Norfolk, in the northwestern part of Nebraska, but the farmers were slow to take hold of the industry, and with the repeal of the state bounties and the national elections of '92 forecasting the repeal of the McKinley bounty and lower prices for beets, a decided set back was given to the industry. On top of this came the drouth year of 1894, with disastrous results. The factories having been obliged to reduce the price from $5 to $4 per ton, not enough were planted to run the factories a reasonable length of time, even had the season been favorable.

The state came to the rescue and by the act of March 25, 1895, offered a bounty of ½ of a cent per pound on all sugar manufactured, provided the price of beets was raised from $4 to $5. This bounty therefore amounts to an extra bonus of $1 per ton on the beets to growers. Thus encouraged, 5000 acres were secured for the Norfolk factory and 4000 for the Grand Island factory for the 1895 crop. The spring was not favorable, the early summer was dry, but later fine-growing weather promised a magnificent crop. Then came what the beet planter dreads almost as much as the cane planter fears early frosts: September opened with a general rain followed by a period of high temperature. The nearly ripened beets, responding to the moisture and warmth, began a period of growth, drawing sustenance from the sugar already stored. Before they could again begin elaborating sugar, a period of cold and cloudy weather set in, checking growth and leaving the beets in an immature condition as a result of these unprecedented climatic conditions. The result was that many beets were rejected by the factory because, being below 12 per cent sugar and under 80 purity, it did not pay to work them at $4 per ton. This caused much dissatisfaction among growers, who at first complained that the factory tests were not reliable, but they employed a chemist of their own and also had analyses made by the state experiment station. This work supported and justified the results reported by the factory chemists, and convinced farmers that the fault was in the weather and not in the factory.

But for the determined efforts of the Nebraska beet-sugar growers' association, it is possible that the whole industry might have stopped then and there. As the bounty was supposed to stand for another year, a grand effort was made to give the industry a thorough trial in 1896. The result was all that could be expected. The crop was perfect in every particular, the weather in September, October and November was as usual all that could be desired, and the factories worked up over 75,000 tons of beets. Farmers have made handsome profits on the 1896 crop, they feel that they have thoroughly mastered the culture of the sugar beet, and they offer to grow many more beets for 1897 than the factories can possibly work up, even should the beets be siloed so that the factories can run until March 1, as was the case at Norfolk on the 1896 crop. Growers who had contracts the past year want to double or triple their acreage and hundreds of others are anxious to raise beets on their own lands, or lease lands for the beet crop of 1897. And this in spite of the fact that Nebraska's supreme court has decided that the state bounty (of which $50,000 was paid on the '95 crop) is not payable unless the legislature specifically appropriates the money therefor. Whether the state will pay this bounty of $1 per ton on the '96 crop is not yet settled, but it is evident that the state will not renew the bounty, so that unless na-

FRONT VIEW OF THE OXNARD'S BEET SUGAR FACTORY AT GRAND ISLAND, NEB.

tional legislation and advancing prices for sugar increase its value, the price of beets for 1897 will be not over $4 per ton. That was the price for '96, the extra dollar being conditional upon the state paying the bounty.

THE RECORD OF THE BEET SUGAR INDUSTRY IN NEBRASKA.

The dry season of 1894 produced beets of a low water content that yielded an average of 216 lbs of refined sugar to the ton, compared to 176 lbs the year before. In 1895, on the other hand, late rains and a warm fall started a second growth which increased the size and weight at expense of sugar, which averaged only 150 pounds of refined to the ton. The average for the last campaign will be fully 200 lbs of refined sugar to the ton and will thus compare with previous years since the factory began operations:

	Tons of beets worked			Granulated sugar produced lbs			No of growers		
Year	G I	Norfolk	Total	G I	Norfolk	Total	G I	Norfolk	Total
1890,	4,414	—	—	736,400	—	—	607	—	—
1891,	10,868	8,179	**19,047**	1,415,800	1,318,700	**2,734,500**	408	204	**612**
1892,	13,055	10,725	**23,780**	2,110,100	1,693,400	**3,803,500**	240	490	**730**
1893,	11,150	22,625	**33,775**	1,835,900	4,107,300	**5,943,200**	135	181	**316**
1894*,	drouth	25,633	**25,633**	—	5,556,100	**5,556,100**	—	534	**534**
1895,	24,343	31,194	**55,537**	2,983,400	5,395,500	**8,378,900**	619	698	**1317**
1896,†	75,000	—	**75,000**	—	—	**15,000,000**	—	—	**2000**

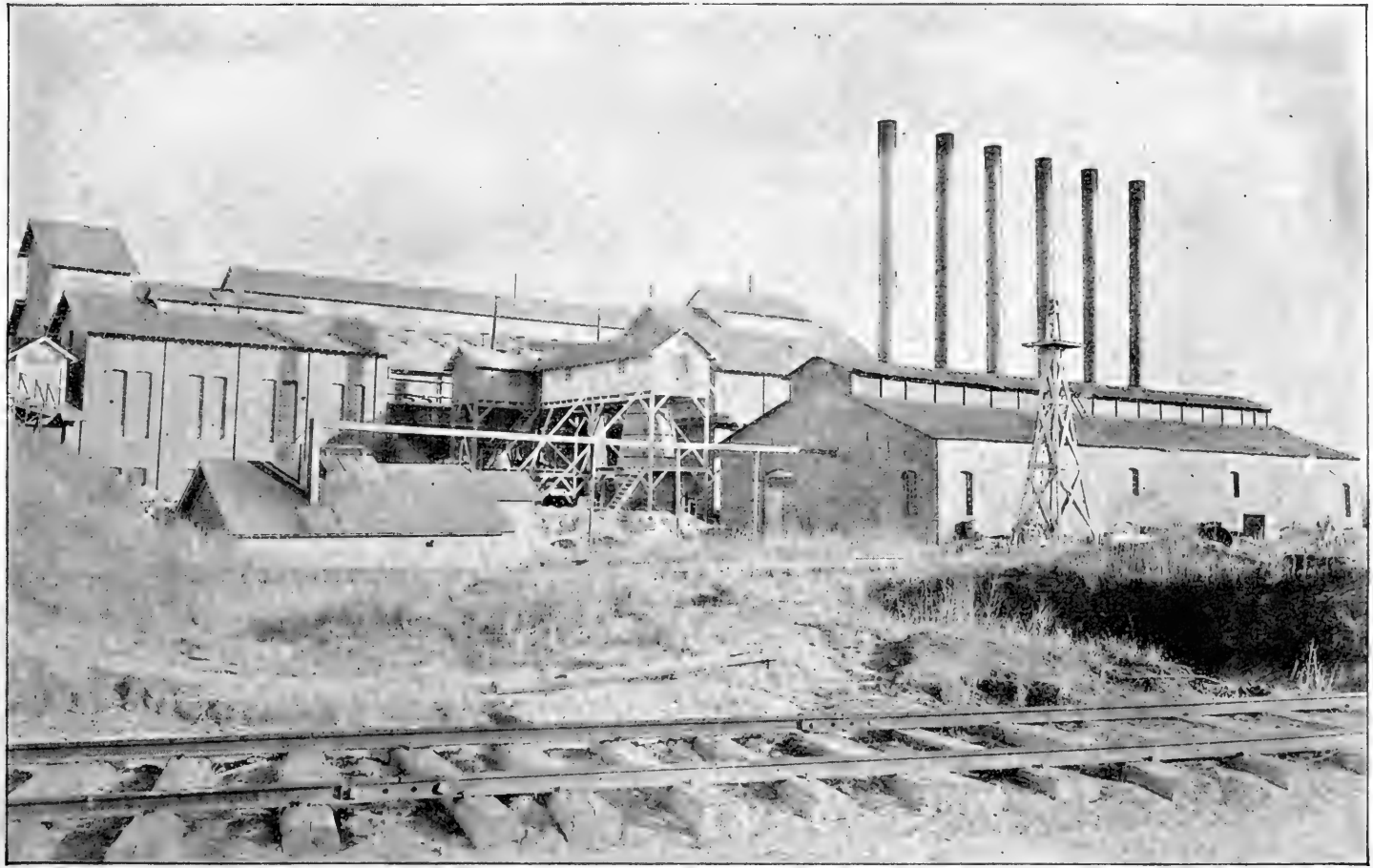
*General drouth made tonnage so small in 1894 that the beets belonging to the Grand Island factory district were worked up at the Norfolk factory. † Partly estimated.

The average yield last year was 10 to 12 tons per acre, but some experienced growers on richly manured bottom land had from 18 to 25 tons per acre, and even more. Growers of beets for these factories are more or less scattered over the state, and much of the crop has to be hauled by rail. The freight is 30c per ton for distances of 25 miles or less, 50c for 25 to 45 miles, and 80c for 45 to 100 miles, the rate being a little higher on another railroad, which exacts an additional charge of $2 per car for switching. The cars are loaded to their visible capacity. The factories paid about $300,000 for beets in '96, or $35 to $75 per acre and even more in a few instances. Renters pay $8 to $10 per acre per year for choice beet land.

But for the splendid and persistent work of the Nebraska experiment station (especially H. H. Nicholson), which conducted tests in all parts of the state and made thousands of analyses, and even conducted a sugar school, the present assured position of the business in Nebraska could not have been reached. The station has made 10,000 analyses, the average of all being over 14 per cent of sugar in Nebraska beets. It is now certain that only moisture and proper culture are needed to enable the beet to be grown to perfection in almost any part of the state. There is a great demand for beet-sugar factories in almost every county in Nebraska.

UTAH.

Keen interest is felt in the beet-sugar industry all over this state, owing to the established success of the (at present) only sugar factory in the whole inter-mountain region of the United States, at Lehi, a few miles south of Salt Lake City, Utah. Beets for sugar manufacturing can be ruined by a superabundance of moisture just at the ripening period. As sugar beets can be grown here only by irrigation, the industry at the outset was surrounded by new and peculiar conditions. The knowledge and science of beet growing (it is a science) were obtained from experts from Cali-



REAR VIEW GRAND ISLAND ESTABLISHMENT.

fornia, but they were ignorant of the methods of irrigation, so it required the combined knowledge of the experienced beet growers of California and the skillful irrigators of Utah to successfully produce our first crop of sugar beets. But the problem has been most happily solved, and to-day Utah produces sugar beets that are fast approaching in quality those of the oldest beet-growing countries.

The growing of this plant is a departure from the usual methods of farming as practiced by the ordinary farmer, in that no part of it can be neglected, or even done

MAP OF EASTERN NEBRASKA

Showing location of the two beet sugar factories at Norfork and Grand Island, and principal points at which beets are grown for shipment. (From Bulletin 44, Nebraska experiment station at Lincoln.)

in a haphazard sort of manner, without sacrificing the crop. It requires intensive cultivation in every sense, but it pays well, a larger cash return being obtained from one acre of beets than from three acres of grain. As the farmers gradually become more familiar with the crop, they steadily increase the yield in tons per acre as well as the sugar quality of the beet.

The farmers of Utah for the first two years took hold of the beet industry cautiously and lightly, preferring to carefully test its merits for themselves before risking too much on a new crop. There were some failures and many successes, but they soon discovered its value, and the increased acreage offered since then has been so great that for the past two seasons the sugar company could not accept it all. At the present writing (March, 1896), there are already applications for over 1000 acres of beets more than can be accepted for the coming season of 1896. During the sugar campaign just closed, the Lehi factory received 33,108 tons of beets from 3300 acres, an average of 11.54 tons per acre; 300 acres averaged about 7 tons, 2000 acres about 11

UTAH BEET SUGAR FACTORY AT LEHI,

Entirely equipped with American made machinery not a single part of the outfit being imported.

tons, while the remaining 1000 acres made about 14 tons per acre of trimmed beets delivered at factory. At $4.25 per ton, the farmers got nearly $162,000 for the crop, from which was made nearly 7,500,000 lbs of refined granulated white sugar. Compared with the previous years the following

TABLE SHOWS THE PROGRESS OF THE INDUSTRY IN UTAH.

	1891	1892	1893	1894	1895
Acres of beets grown,	1,500	1,500	2,755	2,850	3,300
Tons of beets produced,	9,960	9,816	26,809	32,694	38,108
Average yield of beets per acre, tons,	6.6	6.5	9.7	11.47	11.54
Per cent of sugar in beets,	11.0	11.8	11.6	12.7	13.5
Purity of sugar, per cent,	80.0	80.0	79.5	80.2	81.5
*Crude sugar per acre, lbs,	1,452	1,534	2,250	2,913	3,116
*Pure sugar per acre, lbs,	1,162	1,227	1,719	2,336	2,539
Began making sugar,	Oct 12	Sept 26	Sept 19	Sept 25	Sept 5
Finished making sugar,	Dec 8	Nov 13	Dec 21	Jan 5	Dec 31
Days in operation,	58	49	94	103	118

*Estimates added by the author as matters of interest. About 45,000 tons of beets were worked in 1896, for which $4.25 per ton was paid, or a total of about $190,000; paid for labor at factory about $35,000, for coal $30,000 and for other supplies $25,000.

The methods of manufacture have practically reached the same degree of perfection in the successful factories of this country as they have in Europe, showing that the essential factor for the success of the beet-sugar industry of America is the beet root itself. The factory at Lehi, Utah, was the first one to be planned and constructed by Americans and equipped throughout with American machinery. It certainly has many features of excellence to commend it over the European factories. The machinery of itself is more effective in many ways, and its arrangement is such that there is a saving of at least one-fourth the number of hands required in a European factory of the same capacity. During our campaign of 1895, out of which 113 days were occupied in cutting and working beets, it worked an average of 337¼ tons per day, with a factory of only 300 tons guaranteed capacity. As appears from the table above, the length of a beet-sugar campaign is necessarily limited to a few weeks after the harvesting period, for the beets cannot be kept very long without so deteriorating as to be unprofitable for manufacturing purposes. The total yearly expenses, therefore, of an investment of from one-half to three-quarters of a million of dollars, have to be made during a campaign of 90 to 110 days.

The engravings herewith, from photographs taken especially for this work, give an admirable insight into this Utah enterprise. It was projected by men of Utah, who furnished all of the $600,000 invested in the plant, with its 1000 acres of land, with silos and pits for pulp and yards for feeding it to stock. Many shares in the factory are owned among the farmers, and it is in that sense co-operative. The two principal buildings are entirely of brick, the walls being two feet thick, the foundation laid deep, and the piers sustaining the main weight of the machinery being solid masonry resting on bed rock. The main building is 180x84 feet, three stories high. The annex is 184x60 feet. In the latter building are contained ten horizontal tubular boilers, with a generating capacity of 100 horse power each; twenty large char-filters, char kiln with all the necessary apparatus for revivifying the bone charcoal, and the lime kiln, which treats about seventeen tons of lime rock each 24 hours, the carbonic acid gas having to be retained from the lime, as it is necessary in the manufacture of sugar. All the ground floors are solid concrete

PECOS VALLEY BEET SUGAR FACTORY, NEW MEXICO.

The length of the main building is 150 ft, east ell 30 ft, west ell 33 ft, boiler house 43 ft in length. It has a capacity of 250 tons of beets per day. The buildings are so constructed that the capacity can be greatly enlarged when desired. Most of the land is entirely new, bearing its first crop last year. The farmers were also entirely unacquainted with the culture of the beet root, but the results obtained are more than gratifying. Experiments made during the two years previous gave most astonishing results, the crop (all under irrigation) yielding from 12 to 31 tons per acre, with a sugar content of 14 to 21 per cent. This year it is believed that not less than 3000 acres will be grown for this factory.

and all the buildings are lighted with electric lights, which is generated on the premises. There are two sugar store warehouses; one 75x40 feet, the other 125x40 feet, the total capacity of which is 40,000 bags of sugar. The total weight of machinery is upwards of 1000 tons.

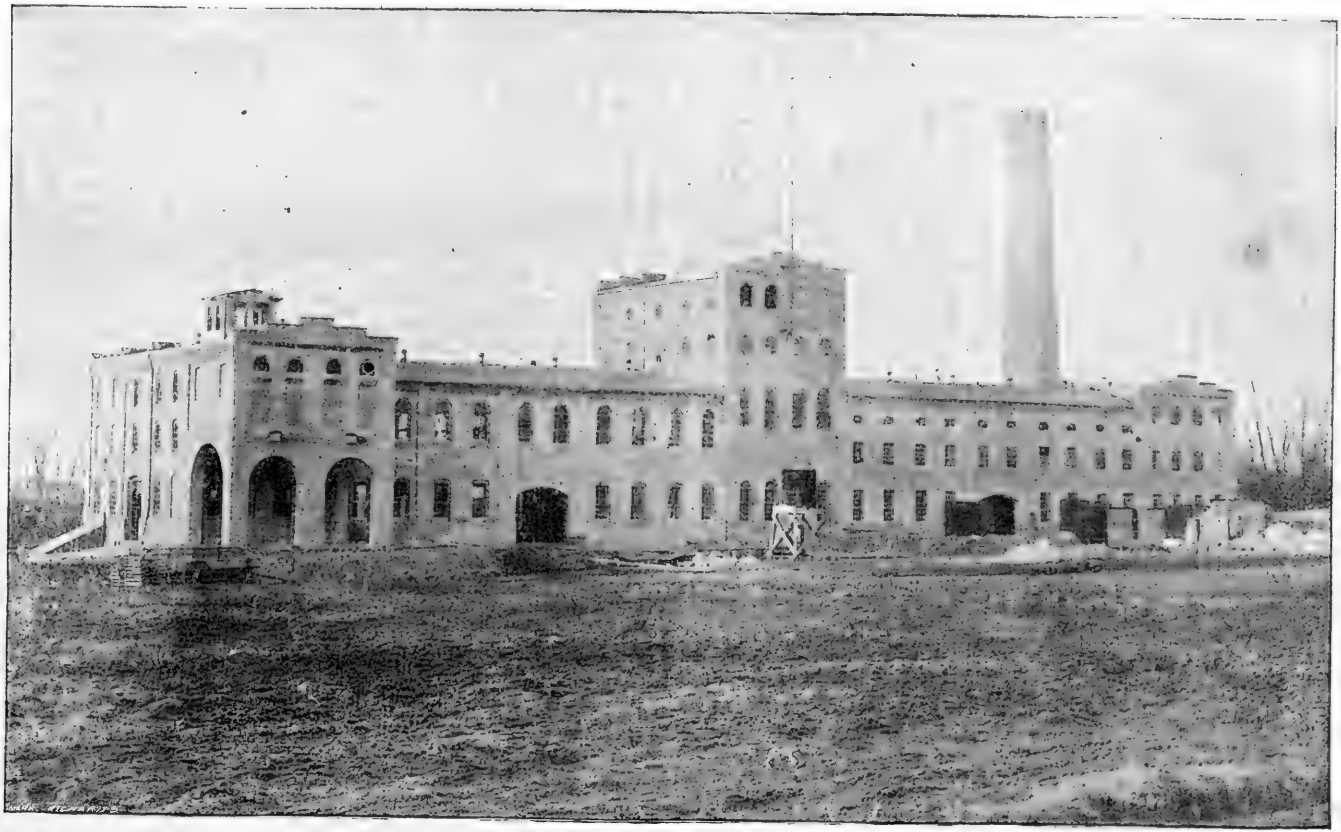
So prosperous has Lehi become that in 1896 there was not a single delinquent taxpayer. This is a remarkable fact for any town, but especially for a western community which has more or less "floating" population. But the Lehi people are "stayers" since the sugar industry is established.

NEW MEXICO.

The Pecos Valley Beet Sugar Co established a factory at Eddy, New Mexico, late in 1896, and are planning for a 700-ton plant 75 miles north of that place, to be erected this year. The Eddy plant was late in starting, and from Nov 25 to Jan 1, '97, received 3706 tons of beets and the total supply was about 18,000 tons. Many farmers irrigated too much and others did not cultivate properly, but in spite of these obstacles the first crop averaged about 12 tons per acre on the 1500 acres grown, while some fields, properly worked, made nearly 20 tons per acre, the range in yield running generally from 8 to 16 tons per acre. The sugar content ranged from 14 to 21 per cent and over 80 purity, and the average for the total tonnage will "probably be close to 16 per cent." Enough has been done to indicate that the arid southwest is likely to prove well adapted to the sugar beet. In spite of the unusual winter weather, in spite of a late start in making sugar, and in spite of all the numerous obstacles that beset such an enterprise the first season in a new country, the company report that their "most sanguine expectations are being realized." Making every discount possible for the claims of interested parties, it is evident that a brilliant start has been made for the Pecos Valley sugar industry. Seldom, if ever, has an enterprise of this kind in the United States done as well its first year.

WISCONSIN.

A sugar factory was erected at Menomonee Falls, Waukesha Co, Wis, about fifteen miles northwest of Milwaukee, in 1896. The enterprise was due to the efforts of Mr K. G. Korn, who has patiently worked for years to develop the enterprise. He is the general manager, having entire charge of designing the factory and building and installing the machinery. He gave his time to the work without pay until the factory was in operation and had the machinery built at machine shops in Milwaukee. On account of the disturbance in financial affairs, the factory was not ready for business until January, '97, but it had nearly 18,000 tons of beets in silos waiting to be manufactured into sugar, as illustrated and described on Page 61. The campaign closed late in March, '97, with a satisfactory run up to latest reports. The greatest difficulty Mr Korn found was to get farmers to grow the beets, but after an 18-months' canvass he succeeded in getting a ten years' contract for growing 2500 acres of beets from 350 farmers within a radius of ten miles of the factory. The contract agrees to pay $4 per ton for all beets testing 12 per cent sugar, $5 for those testing 16 per cent, and an annual premium of $50 for the best grown field of beets. An average test from several of the largest crops of '96 show from 12½ to 13½ per cent sugar, and it is believed that



WISCONSIN'S PIONEER BEET SUGAR FACTORY, BUILT 1896.

View of Menomonee Falls Beet Sugar Factory nearing completion. This substantial building of brick and stone is 240 feet in length by an average width of 58 feet. It represents an outlay of $42,000; complete with machinery, it will cost $160,000. View taken December, 1896. [From Bulletin 55, Wisconsin experiment station.]

the yield will average 12 to 14 tons per acre; many raised 15 to 18 tons per acre, and one crop made 23 tons of good beets per acre. The factory, illustrated on Page 61, has a capacity of 275 tons of beets per day of 24 hours.

This factory is the outcome of elaborate inquiries conducted by the Wisconsin experiment station that show almost the entire state to be wonderfully adapted to the sugar beet. The beet ripens ordinarily by Sept 15 or 20, and until Nov 10 there is little danger from cold, but after that silos will be necessary if a factory is to run much over 60 days. Hundreds of pounds of beets have been grown all over the state and analyzed at the station, showing total averages of from 12½ to 14½ per cent of sugar, while many samples ran up to 18 per cent and the co-efficient of purity averaged over 80. The Vilmorin gave the richest sugar and the Despez Richest the next. As a result of all this work, there is a deep interest in the sugar question.

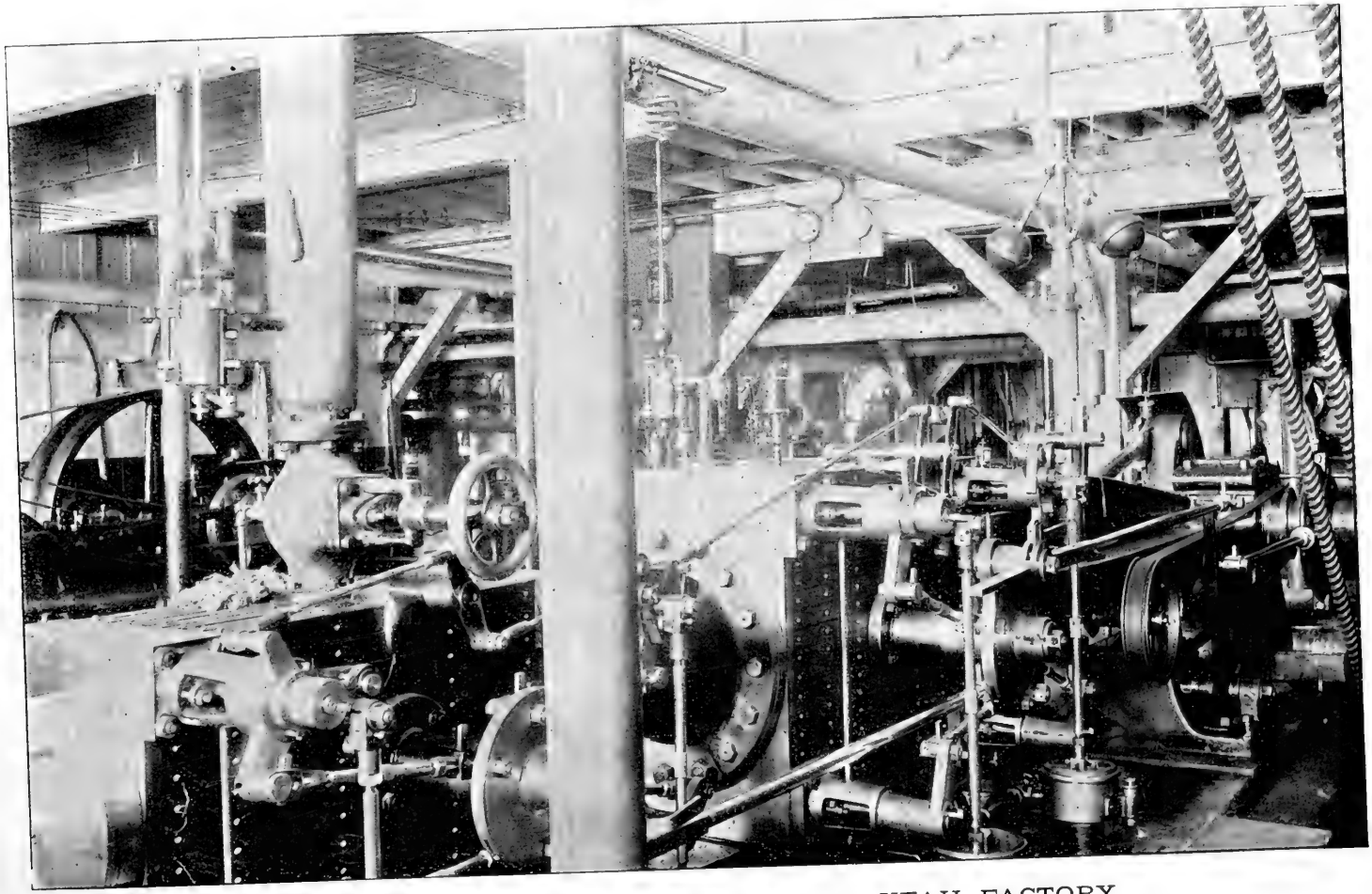
OTHER STATES.

So much for results in states in which beet sugar factories are already in operation. In many other states much work has been done in growing beets to test the adaptability of the soil to this crop. Thousands of analyses have been made by the United States department of agriculture and by several of the state experiment stations. It is evident from all this work during the past ten years that beets can be commercially grown at a profit over most of the vast area indicated in Map No 3, frontispiece—from the Hudson to the Pacific, from the Carolinas to the Lakes. We do not advocate the industry for New England, because the limited areas suitable for beet culture can hardly compete with the wider areas and more fertile soils of the middle and western states.

New York—We did nothing in the way of testing sugar beets in 1895. In the spring of 1894, we sent out 45 packages of seeds to the various counties of the state. The following table sets forth in brief the average weight of beets, the average yield per acre, the per cent of sugar and the average yield per acre of sugar of three varieties in 1894:

Variety	Average weight in ounces per beet	Average yield in tons per acre	Average % sugar	Average yield of sugar per acre
Mette,	32.76	26.5	10.05	5326.5 lbs 2.66 tons
Vilmorin's Imperial,	34.16	34	6.92	4705 " 2.35 "
D K'wanz,	30.59	24.77	9.38	4246.5 " 2.12 "
Average of all,	32.50	28.42	8.78	4759.4 lbs 2.37 tons

These plots were small, and it is to be supposed that the yield was much larger than could have been secured on large areas and that the beets selected were larger than the average. During the season the beets stopped growing in midsummer, and became nearly ripe. Fall rains started them to growing most vigorously and they put out new leaves, which without doubt greatly diminished the sugar content. The largest yield (D. K'wanz) was 56 tons per acre with 8.5 per cent of sugar. The next largest (Vilmorin's Imp) was 54 tons with 5.05 per cent sugar. Westchester county reported a yield of 12 tons and 12.7 per cent sugar of the variety Vilmorin's Improved, and Seneca county 6 tons with 5.7 per cent sugar. The yields and per cent of sugar were extremely variable. In 1893, eight plots of Dippe's Kleinwanzlebener, in various counties, gave an average of 21 tons with 12.86 per cent sugar. Twelve



A GLIMPSE INTO THE ENGINE ROOM, UTAH FACTORY.

plots of Knauer's Imperial, variously distributed, gave an average of 26 tons with 12.5 per cent sugar. Seven plots of Vilmorin's Richest gave 14 tons with 13.2 per cent sugar. Clay soils gave 13 tons with 12.5 per cent of sugar (all varieties); clay loam 22 tons with 13.1 per cent sugar, and sandy loam and gravel 28 tons with 12.6 per cent sugar. We now have two imported varieties growing which will be tested later.—[Prof I. P. Roberts, director of Cornell agricultural experiment station and professor of agriculture in Cornell university.

MIDDLE STATES—Comparatively little has been done in Pennsylvania. In New Jersey, Maryland and Delaware, no proper tests in beet culture have been made recently, but good beets were grown in the 70's, and there is no reason why the crop should not thrive on certain soils properly fertilized. Recent Maryland tests have not given promising results.

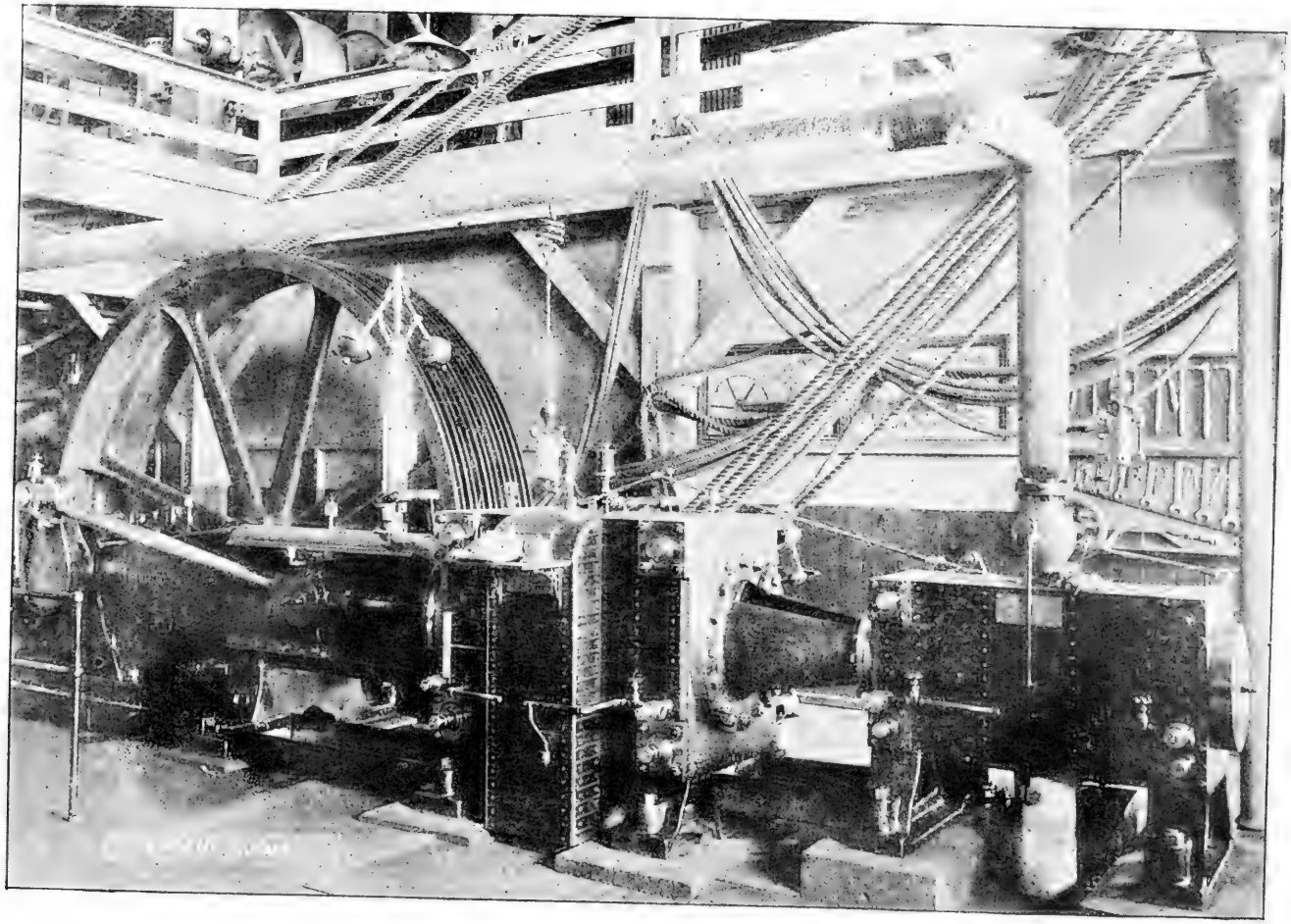
OHIO—The experiment station has done little in this line, but private tests are encouraging, and thousands will be made in 1897.

MISSOURI—In 1890, on upland limestone clay loam of average fertility in Boone county, yield per acre highest 19 tons, lowest 12, average 15; sugar, highest 18 per cent, lowest 10, average 14. In 1891, same farm, yield 8 to 12 tons, average 10; sugar 7 to 14 per cent, average 11½. In '92, tests were made in five northwestern counties, northeast nine counties, southwest five, southeast one county, representing seven different varieties and 55 samples: Per cent of sugar in beets, highest 19, lowest 4.6, average 9.8; purity, 47.5 to 79.3 per cent, averaging 67.3. These varieties at the station in Boone county that year yielded 9 to 12 tons per acre, mean 8.8 tons; per cent of sugar 7 to 13, average 11; purity 65 to 75, average 70. Director Waters says: "Results thus far not encouraging, soil much too compact and hard; Missouri lies south of best sugar belt, mean summer temperature 6 per cent higher than in counties producing this crop most successfully." We suggest much more work for several seasons before throwing Missouri out of the sugar belt.

OKLAHOMA—Little work done. Director Morrow "believes climatic conditions give little prospect of success." But if beets do wonders in Pecos valley, N M, they ought to be tested thoroughly in Oklahoma. This also applies to Indian Territory.

KANSAS—Many plots of sugar beets grown at state experiment stations at Manhattan and other parts of state, '90-2. First year not conclusive; 360 tests in 56 counties were unsatisfactory in '91, owing to climatic conditions. For '92, the station and 85 farmers over the state raised beets, but the season was again unfavorable and the results "cannot be regarded as lending great encouragement to the hope of the successful establishment of the beet-sugar industry in this state. There are, however, a considerable number of samples showing a high percentage of sugar." More work is needed and evidently irrigation or other insurance against drouth is required.

SOUTH DAKOTA—Experiments were conducted in every county, 1889-93, results in four bulletins, of which Nos 27 and 34 can still be supplied. Yield 10 to over 40 tons of beets per acre on acre plots running from 15 to 20 tons as a fair average; sugar content 9 to 20 per cent, very few samples below 12 mostly 13 to 16 per cent, three-quarters of all samples showing 16 per cent sugar or more. Chemist J. H. Shepard



ANOTHER PART OF THE ENGINE ROOM, LEHI FACTORY.

concludes: "The state is well adapted to sugar-beet culture, tonnage very high, purity co-efficient quite satisfactory, averaging about 85."

North Dakota—E. F. Ladd, chemist, reports analyses of beets grown in '91 from 129 farms in all parts of state, yielding estimated average of 13 tons per acre, containing 7 to 18 per cent sugar, average 11.43, purity 46 to 98. In '92, Prof Ladd believed other crops would be more profitable in most of the states; his letter in the fall of '96 expresses no opinion. But further private tests and experiments in Utah, Nebraska and Wisconsin, prove beyond question that the beet sugar industry can be made a great success in most parts of North Dakota.

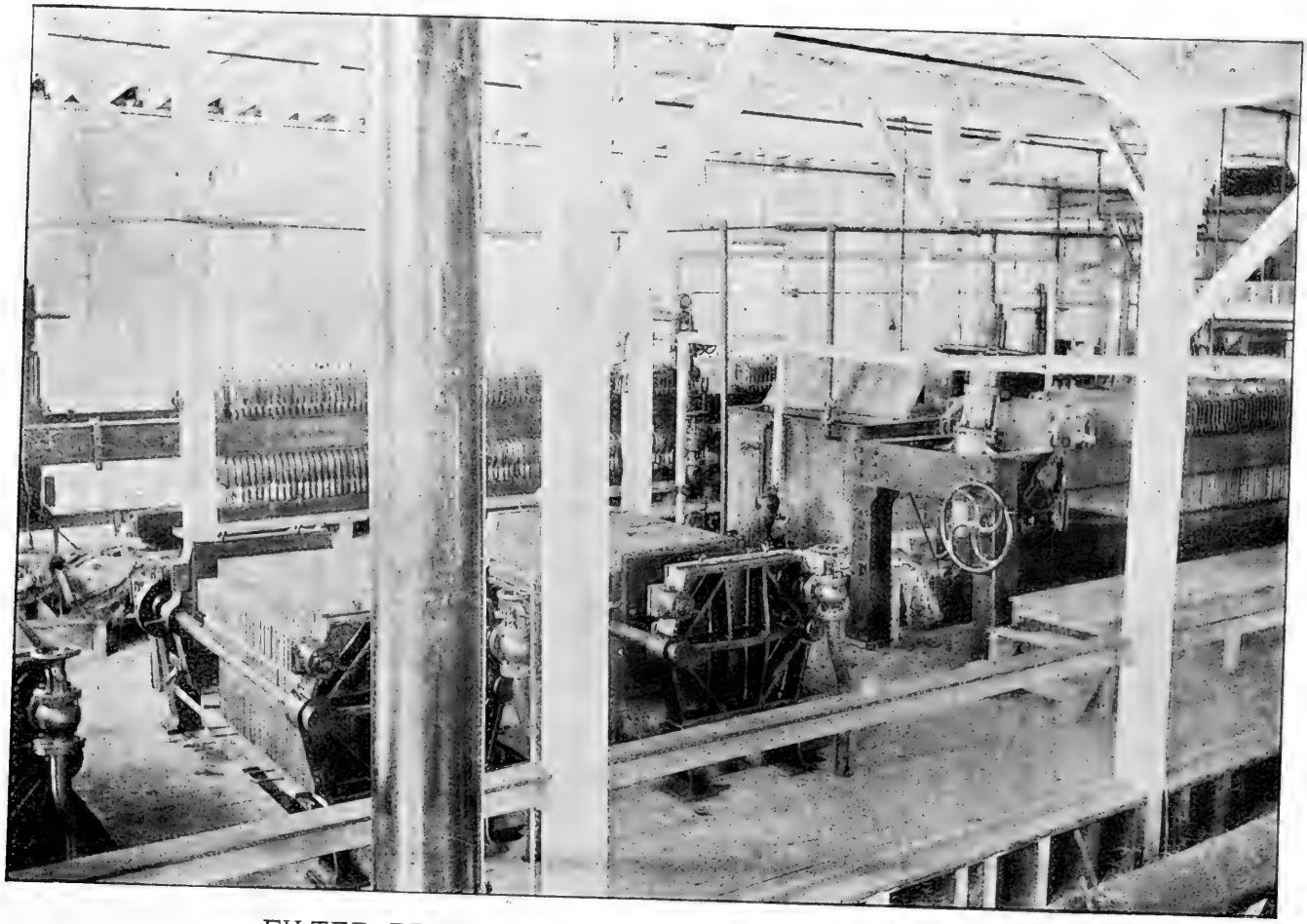
Michigan—Tests were made all over the state in 1891. Season was unfavorable, drouth serious, results conflicting. In western counties 28 farmers reported an average of 15 tons of beets per acre containing over 14 per cent sugar; southeast, 21 reports averaged 16½ tons and 13½ per cent sugar; central, 40 reports averaged 13 tons of 14⅛ per cent sugar; northeastern, 49 reports averaged 15 tons and 13¼ per cent sugar. This makes a promising outlook for both farmer and manufacturer, especially in southern Michigan. See Bulletin 382, Experiment Station, Agricultural College P O.

Indiana—About 300 analyses reported (by H A. Huston, chemist) of beets grown in 150 different localities all over the state in 1889-94, show highest yields of 12 to 42 tons per acre, lowest 3 to 13 tons; sugar, in juice, highest 14 to 18 per cent, lowest 5 to 10; purity, highest 87 to 90, lowest 58 to 70. Small plot tests prior to '94; that year, ten fields of ¼ to 1 acre averaged 19 tons per acre, and half of these fields gave beets of quality sufficient for sugar manufacture. Chemist Huston adds: "Beets of satisfactory quality can be grown in all parts of Indiana. With one exception, all correspondents who have raised beets in large plots believe that at $4 per ton this crop would pay a profit." H. Cordez, who has been working for two years to establish a factory near Evansville, southern Indiana, obtained 15½ and 16 per cent sugar of 85 to 90 purity in small plot tests in '96.

Illinois—Because farmers failed to raise enough beets to run the factory at Freeport many years ago, and because on some soils the crop did not seem to thrive, the impression has gone out that this state could not grow beets. The experiment station has done very little to ascertain the truth. Until the matter has been as widely tested as in Minnesota or Wisconsin, correct judgment cannot be formed. Until such tests prove to the contrary, we shall believe Illinois has thousands of acres that can be readily adapted to this crop.

Minnesota (Prof Henry Snyder)—It has been the aim of the state experiment station to test, in as thorough and impartial a way as possible, the adaptability of Minnesota's soil and climate to the growing of sugar beets. The work has been carried on for eight years, during which time 1079 samples of sugar beets have been analyzed, showing of sugar 10 to 20 per cent, an average of 14 per cent; purity 70 to 94, an average of 80½. The beets have been grown in a large number of counties throughout the state. It is believed that the experiment station has demonstrated that sugar beets, with a high per cent of sugar and co-efficient of purity, can be raised in Minnesota, at a cost of $2 to $3 per ton. The average yield per acre was 15 tons.

Iowa—For the purpose of ascertaining by repeated experimentation how well Iowa is adapted to growing sugar beets, we began in 1891 and have grown and tested



FILTER PRESSES, UTAH BEET SUGAR CO., LEHI.

sugar beets every year since that time. We have probably three or four acres growing on the station grounds at present. Seed has been sent to a majority of the counties of the state, so as to give us wide and comprehensive reports regarding the ability of our state in its several counties to grow beets with a sufficient percentage of sugar to make the industry profitable.

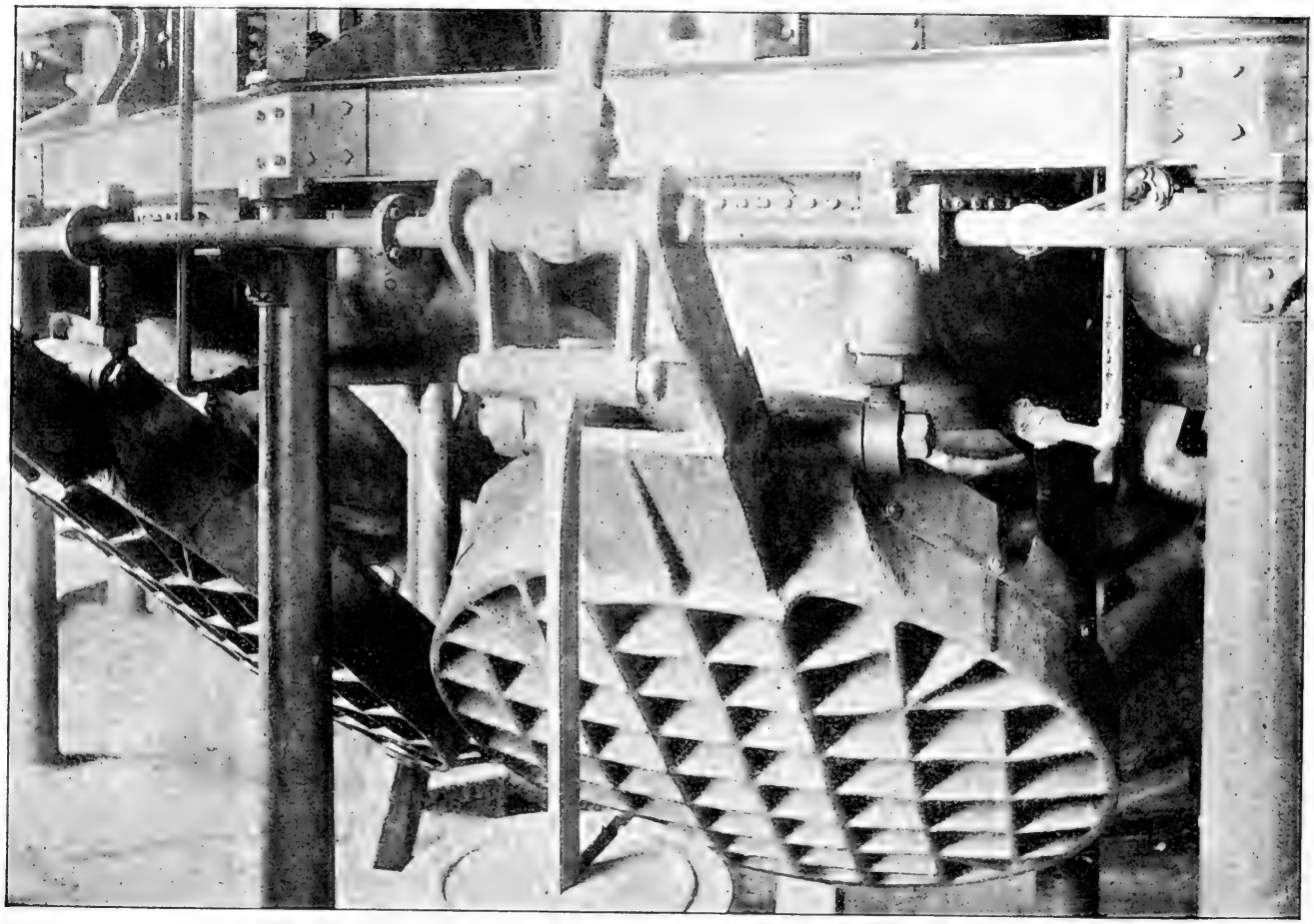
We also, in 1891, conducted an experiment on the college grounds with a piece of land over an acre in extent, having different kinds of soil and treated different ways, so as to ascertain what soil is best and what method of cultivation is advisable. From the whole field, we got an average of 20 tons to the acre with 14.14 per cent sugar in the beets, and 76 per cent average purity of juice. We grew this field of beets under twelve different conditions. We used different kinds of fertilizers on three pieces, but got no evident benefit; we got our highest average of sugar from the piece of ground from which woods had been cleared off, 15.17 per cent of sugar with 82.3 purity of juice. We let one part of the field on low, rich loam grow the beets as large as we could possibly grow them by thinning them out; the average purity of juice went down to 72.8 and the sugar in the beet was 11.52. Only three of the twelve conditions gave us sugar in the beet under 13 per cent. We got the greatest tonnage from early planting; subsoiling gave us the best shaped beets. The percentage of sugar was affected by rains in October causing a second growth. Our highest analyses came from beets averaging 13 ounces trimmed, and yielding 12 and 13 tons per acre; our highest yield of sugar per acre came from beets averaging 21 ounces trimmed, and yielding over 28 tons to the acre. Clay soil gave us the highest per cent of sugar, comparatively higher purity, and lowest tonnage per acre. We had no distinctively sandy soil.

Reports from different counties in the state show a wide range of sugar per cent and purity co-efficient. The highest we have received comes from Muscatine county; over a hundred farmers reported from that county in 1891. About 10 per cent reported a sugar per cent under 12, while half of the number report the sugar in the beet over 15 per cent, and some run as high as 19 per cent.

I have no doubt that a large area within the state will grow sugar beets profitably. The purity of the juice is not as high in our state in all parts as it is in others, but the yield per acre has much to do with the profitableness of the crop, and from reports of the growth of beets west of us, I am satisfied that our tonnage is much heavier than is common in drier states. Iowa soil is so well supplied with plant food of all kinds, organic and mineral, that no fertilization is required. We sent to Louisiana and got the most approved sugar-cane-growing fertilizers, but were unable to see any improvement whatever from their application. Our soil has abundant lime, pot ash, phosphoric acid and nitrogenous compounds, so that apparently only capital and skill are necessary to make all of the sugar in Iowa that the United States may require.—[James Wilson, (Director Iowa experiment station; Professor of Agriculture Iowa Agricultural college; Secretary of Agriculture for the United States—1897-1901).

IN THE WEST.

There is no longer a shadow of a doubt as to the adaptability of vast areas to the sugar beet, although it is true that more extended experiments are necessary in some sections to further demonstrate the quantity and quality that can be raised. Espe-



LIDS OR COVERS OF DIFFUSION BATTERIES.

For description of the uses of diffusion jars, see the account of process of manufacturing beet sugar on page 41.

cially is this true in Montana, where practically nothing was done in this line until the past year. In Wyoming, on the other hand, many tests were made 1891-5, showing average yields of from 8 to 14 tons per acre, an average sugar content of from 16 to 17 per cent with from 78 to 83 purity. Summarizing all this work done by the state experiment station at Laramie, Prof Buffum concludes that "the yield averages sufficient to make it a profitable crop, while the beets are of better quality than in many states where factories are successfully operated."

In Colorado, more than 50 localities have grown beets and the conditions have proven favorable everywhere under 7000 ft altitude, though best under 6000 ft, when the ground and crop are properly handled. Co-efficient of purity is good. The yield runs from 10 to 15 per cent of sucrose, averaging fully 13 per cent, and under proper conditions much more than that. Results in New Mexico, Arizona, Utah and California have already been enumerated.

In Idaho, the yield runs from 10 to 26 tons per acre with a large sugar content of high purity. In Washington, very fortunately, a great number of experiments have been conducted in most parts of the state under the auspices of the state experiment station at Pullman. Over 1700 analyses have been made, showing an average of more than 15 per cent sugar of nearly 84 purity. The beets from almost every county closely approximate this standard. It is a remarkable showing and demonstrates beyond a peradventure that the state of Washington is singularly adapted to the industry. The average yield per acre is not reported, but Prof Fulmer says: "It is probable that an average of 20 tons per acre would be a conservative estimate." Allowing for the extraordinary richness of Washington soil, it is probable that this is rather high. In Oregon, tests were conducted for three years 1891-3, and again last year, showing that beets raised under all sorts of conditions varied from 8 to 22½ per cent sugar in the juice of above 80 purity. Prof G. W. Shaw's analysis of beets grown by an expert in Washington county the past year averaged 16½ to nearly 18 per cent sugar of 88 to 91 purity, and even after the second rains in the fall these beets averaged over 12 and 80. Prof Shaw believes that even west of the Cascade mountains, the earlier crops of beets would be harvested before the fall rains start a second growth, and that even in that region as well as east of it, the state is wonderfully adapted to the sugar beet.

IN THE SOUTH.

Virginia—Mr O. K. Lapam, who operated a small factory at Staunton, Va, for two or three seasons, until it was burned, is enthusiastic over the possibilities of the industry in this section. The beets averaged 14 to 14½ per cent of sugar and yielded an average of from 12 to 13 tons per acre, at a cost of from $10 to $40 per acre including delivery of beets to factory and fertilizers as well as all other expenses. He estimates the average cost at $25 to $30 per acre in the south when beets are grown within five miles of the factory. At $4 per ton and an average of 12½ tons per acre, the income would be $50 per acre. To this should be added six tons of pulp, worth to the farmer $2 per ton or $12 per acre, while the improvement of his land by deep tillage and thorough destruction of weeds is at least $5 more. The crop which follows beets will yield 50 per

cent more than on the same land not having been previously used for beets. Mr Lapham "knows of no industry more needed in the south than this to improve the land, while insuring a sure and profitable return to the farmer, and incidentally benefiting all classes connected with it."

In North Carolina, sugar beets have not been tested since '87-8, when the results were discouraging. Director H. B. Battle of the experiment station at Raleigh says: "Should there be a demand for the product for manufacturing sugar, the cultivation could be rapidly and successfully developed."

In Kentucky, Director M. A. Scovell of the experiment station at Lexington is not hopeful of results, owing to the comparatively low sugar content, but H. Cordez cultivated three kinds of sugar beets on an alluvial soil in Green River valley, western Kentucky, in '96, which showed 16 to 17½ per cent sugar of more than 80 degrees purity, and he is very confident that the crop will thrive over much of this state.

In Tennessee, Secretary Vanderford of the state experiment station at Knoxville, writes: "I am satisfied that there are areas of considerable extent in all divisions of the state, and particularly in west Tennessee, where sugar beets of more than average sucrose content and of high purity can be grown at an average cost of $3 per ton or less. Under adverse conditions, upon an unsuitable soil on our station farm, we have demonstrated that sugar beets can be made profitable in Tennessee."

The Arkansas station reports having grown sugar beets in three parts of the state but the yield and sugar content were varying and unsatisfactory. "The temperature is hardly suitable in this state, except perhaps in the northwestern part," say Director Bennett, but we would suggest more exhaustive inquiry before accepting the accuracy of this opinion.

Prof W. C. Stubbs writes: "It is doubtful whether the sugar beet can be grown south of the Ohio river with profit. Our experiments in Louisiana have clearly shown that no reliance can be placed on the sugar beet crop in this state. This is due to the fact that frequently beets are planted here in the fall and are grown throughout the entire winter. It is with us more of a fall and winter crop than a summer crop, and since sunshine is needed to elaborate the sugar, it is rarely that we find beets here rich in saccharine matter."

No tests are on record as to the adaptability of the soils and climates of northern Mississippi, Alabama, Georgia and South Carolina to the sugar beet, although it is probable that the crop will be widely tested all through these regions.

In Texas rich beets are raised in the temperate climate of the semi-arid region under irrigation, but in the warmer and more humid part cane does better, as beets here are poor in sugar.

Certain practical men, who have had large experience in sugar-beet culture and manufacture in this country and who are also acquainted with European conditions, are strong in the belief that the middle south, meaning especially Virginia, West Virginia, Kentucky and Tennessee, will yet prove to be a fine location for the beet sugar industry, because of the long season, abundance of sunshine, nearness to market and other conditions.

A FIELD OF 210 ACRES OF SUGAR BEETS IN THE PECOS VALLEY,

On the celebrated Vineyard Farm, Eddy, New Mexico.

CHAPTER III.

CULTURE OF THE SUGAR BEET.

CLIMATIC CONDITIONS.

BEETS THRIVE BEST in a temperate climate, which in the United States covers a vast area. While the plant develops under a great variety of weather conditions, more recent experience seems to confirm in a measure the previously accepted theory that the sugar beet as a rule does best in regions where the average temperature for the months of June, July and August is about 70 degrees F. This isothermal line has been carefully determined by the United States department of agriculture and is indicated on map No 3. (See frontispiece.) Dr Wiley in 1890 regarded the sugar beet belt as extending about 100 miles on each side of this line. Experience since shows that the area adapted to this crop is by no means limited to this belt and that it is far larger than has been supposed. The map referred to indicates in a general way the area in which both soils and climates can be found peculiarly adapted to the sugar beet.

Sunshine is required to make sugar. Hence, the number of clear and sunshiny days that can usually be depended upon in any section is an important consideration, which has not been sufficiently emphasized in much of the literature heretofore published. This explains the advantage of many parts of the so-called arid west for this industry, especially California and the Southwest.

Another important climatic consideration is favorable weather during the ripening and harvesting period. Clear sunshine, absence of fogs and moisture, are important at this period. We have seen how in 1895 a fine crop of sugar beets in Nebraska was almost ruined by a warm, wet spell early in the harvesting time. While this is unusual in many of the eastern and central states, it is liable to occur in most of the country east of the 100th meridian. Such weather starts a new growth of the beets that consumes the sugar or changes it to starch, and it requires several days of sharp sunshine and warmth, without too much humidity, to restore the sugar content.

The beet must also have sufficient moisture at the right time to produce the best results. This moisture must come either from the rainfall, from irrigation or "the soil must be of that peculiar quality that will allow subterranean moisture to reach the rootlets of the plant," which is the case in parts of California and some other states. While proper cultivation of a subsoil soil will enable the beet to thrive with

more or less water, Wiley maintains that an average summer precipitation of 2 to 4 inches per month is desirable. Nebraska experience shows that a good crop is assured, provided other things are done properly, if May and June are warm and not too wet, July and August wet and not too hot, September and October warm and dry.

The longer the season the more favorable to this industry. In California, planting begins as early as January on the higher and dryer soils and continues until June on the lower and more moist lands, thus maturing the crop continually from about the first of August to almost the new year. In the vicinity of Watsonville, planting of the '97 crop began as early as Jan 15, while the last of the '96 crop was hardly out of the ground on the last day of the year. In other parts of the country, the planting has to be done in a short time, usually during May, because the ground is too cold and later the season will be so short as to prevent maturity before frost.

Another advantage in the mild climate is the longer period of harvesting. As just noted in California, beets may be harvested during the last five months of the year, whereas in most other sections, the digging must be completed before hard frosts. It has been assumed that beets would keep longer in the mild winter of California (where frost is almost unknown) than in the severe winters of the north and east. It has been customary to keep the beets in cold climates in silos but Utah experience during the winter of '96-7 indicates that such protection against cold may not be as necessary as has been supposed. This point is further discussed under the head of storing beets. Certain it is that a climate which allows a factory to run from 100 to 150 days in ordinary seasons is far more advantageous than sections where the mill can not have good beets to run on more than 80 or 100 days.

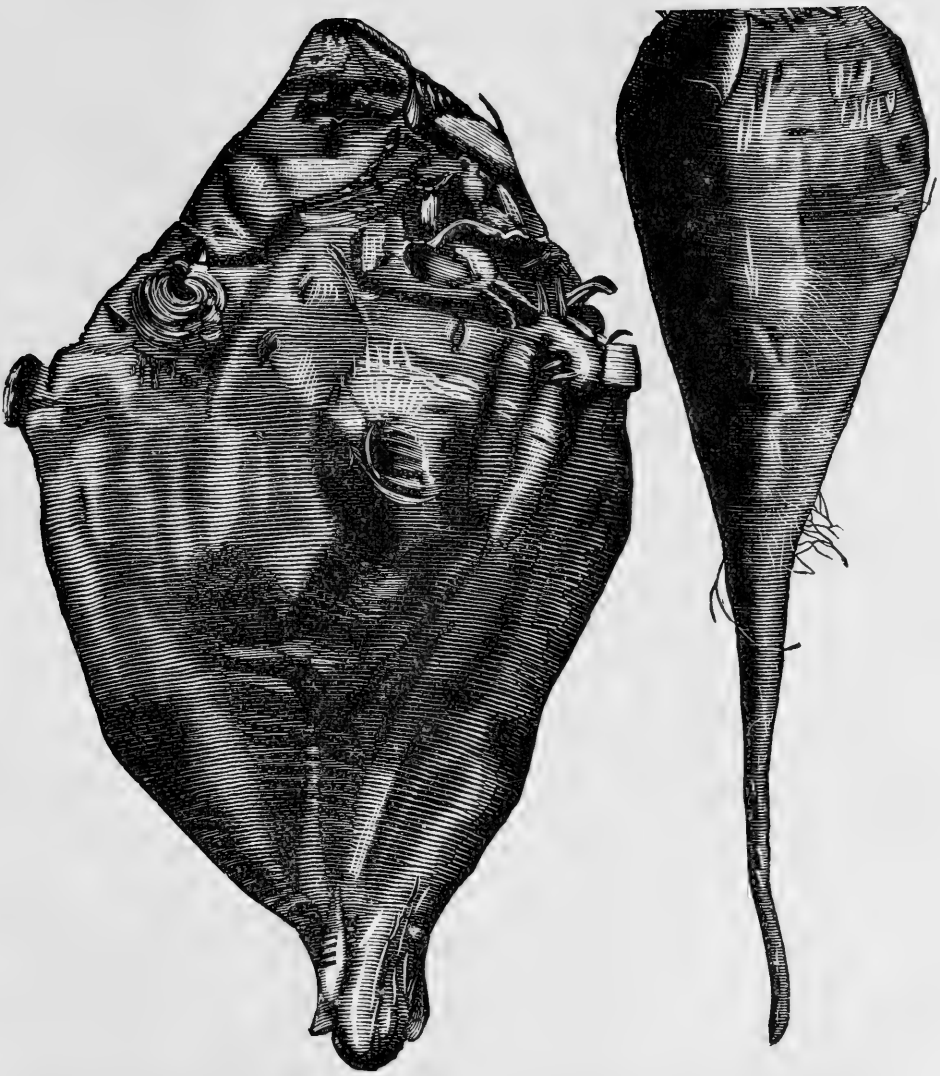
VARIETIES OF BEETS.

"All kinds of sugar beets are botanically identical with the common garden beet, *Beta vulgaris*. The differences in varieties have arisen by reason of special selection and culture producing a pure strain of some valuable peculiarity in the beet. These accidental valuable qualities by careful selection have become fixed and are associated with certain external properties which have thus come to be regarded as distinguishing characteristics.

"The shape and size of the beet, its color, the character of its foliage, whether erect or spreading, etc, are the most frequent marks of distinction. The beets are also frequently designated by the names of those who have developed them, or by the name of the town or locality in Europe in which they have been grown, or by their color.

"Among the more frequently occurring varieties grown in Europe may be mentioned the Vilmorin Improved, Klein Wanzlebener, Improved Klein Wanzlebener, White Excelsior, White Imperial, Simon Le Grande, Florimond and Bulteau Desprez Richest, Brabrant Sugar Beet, Rose Imperial, White Silesian, etc,

"The two varieties which have been most widely grown in this country are the Vilmorin Improved and the Klein Wanzlebener. The certainty that the seed has been grown according to the most scientific methods is of greater importance to the beet grower than the variety. The beet has reached such a high state of perfection



A POOR BEET,

Of large size and great tonnage per acre, but deficient in sugar, containing much woody fiber, improperly topped, and highly undesirable for factory purposes. Such beets weigh 4 to 6 lbs. and contain 5 to 8% sugar.

A GOOD BEET.

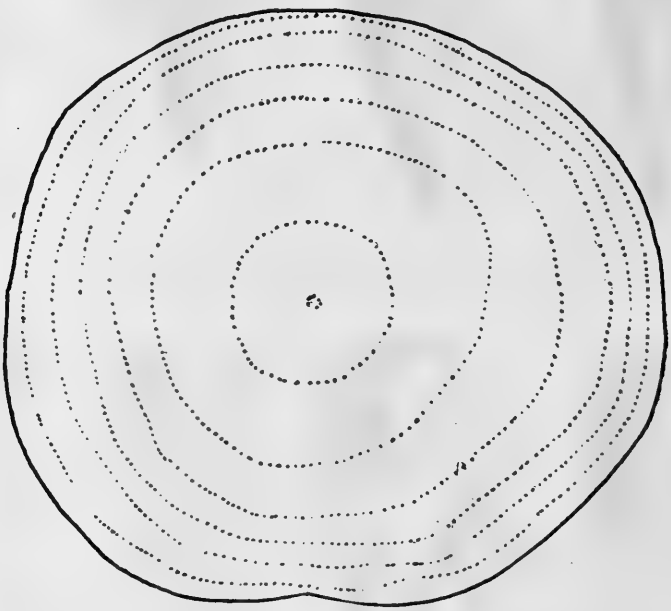
This beet is not quite so fine a type as that shown on Page 32, but it is rich in sugar, containing 13 to 16% or more, weighs 1½ to 2 lbs, it is properly topped, and is just what the sugar factory wants.

The pictures are reproduced from Bulletin 13, Nebraska experiment station.

as to make the least degree of laxity in its treatment exceedingly dangerous to its qualities."

The two kinds named are preferred in California, Nebraska prefers Dippe la plus Riche, Dippe Klein Wanzlebener, Original Klein Wanzlebener, and Vilmorin's Improved White. The two latter varieties are mainly grown in Utah.

No variety of sugar beet is suited to all conditions. Different soils and treatment make peculiar demands upon the variety. Experience with varieties in other parts of this or foreign countries is not a safe guide. The only practical way is to find out by actual experiment on each farm which variety does the best in yield and quality under its conditions. The seed must be good—of strong germinating power. "Cheap"

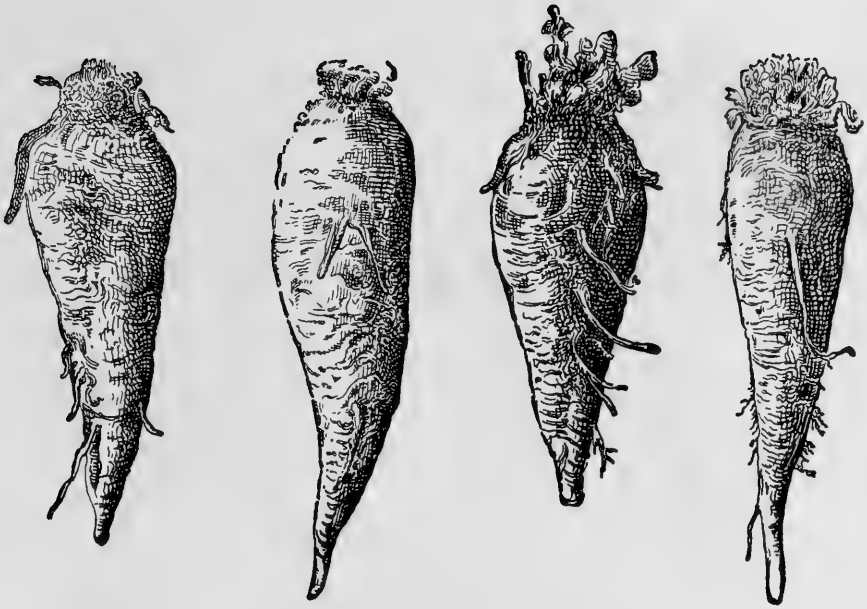


CROSS-SECTION OF BEET

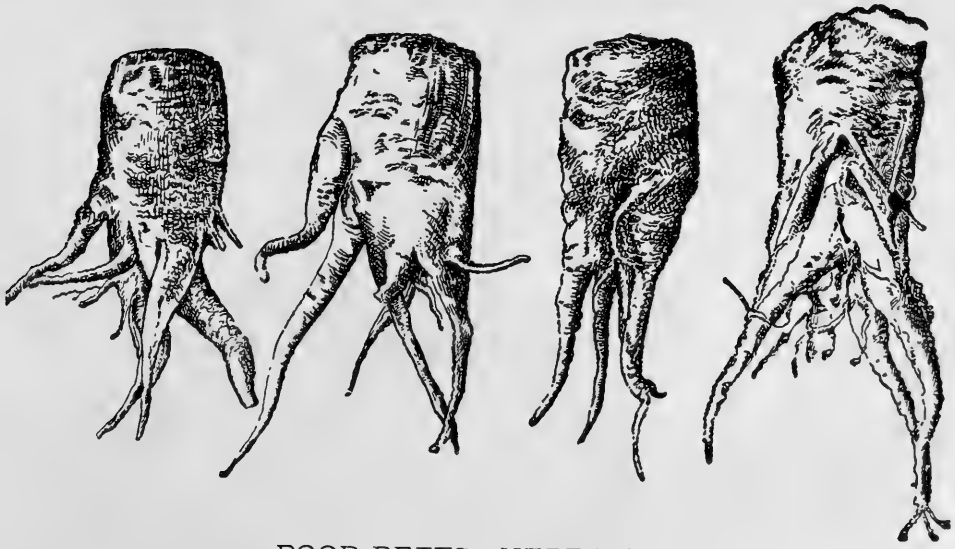
Illustrated on page 32. This cross-section is life size at the point of largest diameter. The dotted lines show the concentric rings of growth.

seed is in the end the most costly. This country is producing some seed now, and in a few years will doubtless grow all its beet seed, as discussed later in this chapter.

SIZE OF BEET—It is generally considered that large beets, weighing more than 3 lbs, are usually of poor quality. This depends entirely upon the soil upon which they are grown, and upon the variety of seed. As a general rule, however, it can be said that the large beets are lower in quality than small ones. The size most desired is from 1½ to 2 lbs in weight. Where beets are too large or too poor in quality to be worked at the factory, they can be utilized for stock feed. For this purpose the beets are considered in France worth 75 per cent as much as the price that is paid for them for sugar making. In France, almost twice as many beets are grown for



FAIRLY GOOD BEETS.—NEBRASKA.



POOR BEETS.—NEBRASKA.

The first plate represents beets of White Silesian variety grown on good soil and with proper care and plenty of cultivation. The beets are of good form and show good characteristics, and would be sought after by factory. The second plate represents beets of White Silesian variety grown on same soil from same kind of seed, but without proper care and with insufficient cultivation. They have no good characteristics, and are dreaded by factory, and are only fit for forage purposes. From Bulletin 16, Nebraska experiment station.

stock food as for sugar. In that country the leaves are sold to adulterate tobacco and it is said that in some cases fully enough to pay for the expenses of cultivation.

SOILS FOR THE SUGAR BEET.

This plant thrives on a wide variety of soils. In Virginia, a warm clay or slaty soil, mixed with some sand and having a depth of 15 inches or more, gave the best results. In other states where the industry is not yet established, experiment shows that the plant thrives on nearly all kinds of lands. But never select poor land—use the best soils available. It seems to do best in these regions on what farmers ordinarily call good potato or corn land. The soil must be well drained, for while the beet requires abundant moisture during the growing period, it does not thrive with "wet feet." It therefore does much better in some soils than in others. The soil must possess good depth, for the beet is a deep-rooting plant, going down 12 to 18 inches.

In Nebraska, the best soil to produce a large tonnage is the so-called bottom land. Hilly land produces generally a better quality, but does not come up as well in quantity. The more lime the soil contains the richer the beets would be. Under no circumstances should seed be planted in soil which is sandy enough to blow. In Utah, and also in the Pecos valley, where one has plenty of water for irrigation, a nice sandy loam is preferred, but if the water supply is scant a clayey soil is better.

In California, the rich, strong, sandy loams that produce heavy crops of wheat and barley yield 15 to 25 tons of rich beets per acre under proper rotation, but lower lands, when well drained of wet or that enjoy natural sub-irrigation from the lower stores of water, are often still better. It has been found at Chino that even when the lower or more moist lands contain as much as 12,000 lbs of alkali salts per acre to the depth of three feet, the beet does well in yield and quality, provided the amount of common salt in the soil does not exceed 0.04 per cent or 1500 lbs per acre to the depth of three feet. But it is wisest to verify on a small scale the adaptability of doubtful land before planting a large area of it.

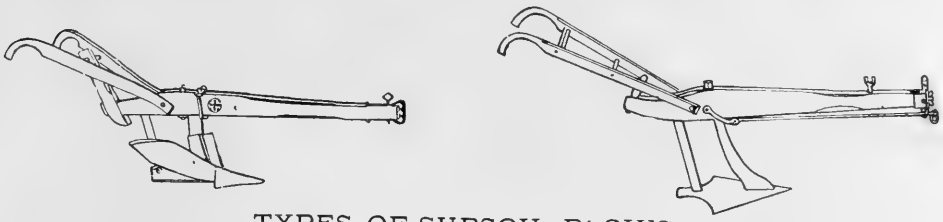
New land, by which we understand land that has only been broken one or two years, should never be chosen for beets, as it produces a crop inferior in yield and quality. In Utah, the best results in sugar and purity are obtained from land that has been in small grain and the best tonnage is obtained from land that has previously had potatoes. Alfalfa land is good for beets, provided two crops of small grain are first grown upon it to get rid of the roots. For preparing new land for beets, nothing is better than to first plant alfalfa or field peas, the latter to be plowed under when in flower. Sage brush or mesquite land is excellent, provided it is thoroughly subdued by preparatory crops, and can be irrigated.

It is also important that the soil be such that the beets can be easily extracted from the ground by a beet puller or plow without breaking the root and without having a lot of soil adhere to it. In this particular, the sandy loam is ideal. To dig the root from a clay or adobe soil is hard work; in such soils the beet tip often breaks off when ripe, and much soil adheres to the beets, thus adding to the freight and to the "tare."

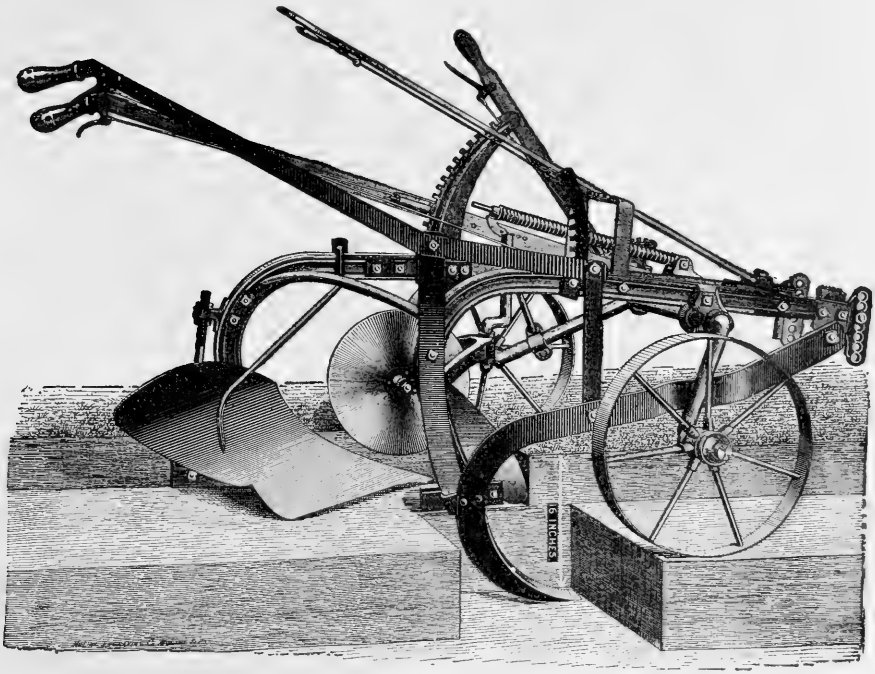
ROTATION OF CROPS.

This is highly important. Beets may do well year after year on the same land, especially if properly manured, but the constant draft upon the soil for the same pro-

portions and kinds of food which this plan involves, must soon impair results. Three crops in succession in Nebraska's rich soil showed marked deterioration in quality. Constant cropping with beets also tends to perpetuate or multiply any pests (insect or fungus) of this plant. It is true that beets have been grown continuously on the same land in California for a dozen years, without apparent injury to yield or qual-



TYPES OF SUBSOIL PLOWS
To follow in the furrow after the first plowing by ordinary plows.



GANG PLOW WITH SUBSOILING ATTACHMENT.

ity, but this does not gainsay the axiom above laid down. Thus far, best tonnage and quality have been secured in California from beets grown on the land every third year, and in Nebraska every fourth year.

New land should be subdued, as stated on Page 78, before being grown to beets. This crop should always follow corn or small grain, because these being harvested early, the land is free for the fall plowing that is absolutely essential to best results with the beet. In Nebraska corn does not seem to do well after beets, neither

should potatoes or other gross potash-feeders immediately precede or follow beets. The best rotation in Nebraska is (1) beets, (2) wheat or oats, (3) corn, (4) wheat or oats or barley, (5) beets. If beets are wanted every third year, the Nebraska rotation is (1) beets, (2) small grain, (3) corn, (4) beets. Utah experience with rotations is limited.

In northern California, beets follow barley most admirably, wheat being the next crop—(1) beets, (2) wheat, (3) barley, (4) beets. Much is yet to be learned about the best rotations under American conditions, but one including one or two crops of clover or alfalfa will usually be found excellent. Instead of giving small grains the second year, a few Nebraska farmers prefer to allow the land to remain fallow, plowing it five or six times to prevent a growth of weeds, then cultivating only in spring before seeding.

FEEDING THE PLANT.

The sugar beet has thus far been mainly grown in America for commercial purposes on comparatively virgin soils at the west without fertilization. In Europe, on the other hand, the liberal use of fertilizers is essential. It is already being found that even our virgin soils will deteriorate if there is not put back upon the land the plant food taken from it by the crop. While the beet takes comparatively large quantities of plant food from the soil, much of this can be returned to the land if the pulp and tops are fed to stock and the solid and liquid excrement applied to the soil. The lime cake and the bone black from the sugar factory should also be used.

AVERAGE QUANTITIES OF PLANT FOOD REMOVED IN 1000 POUNDS EACH OF BEET ROOTS AND BEET LEAVES.

Constituents	Roots lbs	Leaves lbs	Total lbs
Potash,	3.3	6.5	9.8
Phosphoric acid,	0.8	1.3	2.1
Magnesia,	0.5	3.0	3.5
Total ash*,	7.1	18.1	25.2
Nitrogen,	1.6	3.9	4.5

*The ash includes a large proportion of lime.

It will be seen that the leaves contain more than twice as much of the principal elements as do the roots. Hence, the wisdom of leaving them on the field, if not fed to stock. Magnesia and lime are supplied to the soil at low cost in the form of lime cake. The plant requires much lime, and if it is not sufficiently present in the soil its absence must be made good. The plant is a most liberal feeder of potash and nitrogen, its demands for phosphoric acid being comparatively limited; hence, the wisdom of applying fertilizers containing an excess of potash and low in phosphoric acid. We would especially emphasize the importance of potash, for even if the pulp is fed to stock and their manure applied to the land, more or less potash is lost in process by leaching or in the molasses, etc, as well as by failure to utilize all the liquid manure. Potash and phosphoric acid can be used very freely on beet fields and seem to do better together than when applied separately. This is not so with nitrogenous manures or ammoniated substances, which tend to produce a quick and heavy growth of the beet and thus diminish its sugar content. As a general rule, it will be found that in the older and more exhausted soils, the generous use of fertilizers or manures is advisable, as the land must be made rich. On the newer soils at the west, just what

A WISCONSIN PIONEER BEET FIELD.

View of 18 acres of sugar beets grown by Francis Walterlin, Menomonee Falls, Waukesha Co., Wis., season 1896. (From Bulletin 55, Wis. Experiment Station

fertilization is best is yet a subject of experiment and much is also to be learned about fertilizers on old land.

In all cases, the crop seemed to do best if the ground was manured the second year before the season the beet is to be raised. Well-rotted stable manure to be plowed under is advisable and in Nebraska results in greatly increased tonnage. In Utah, on the other hand, there has been a disposition among growers to put too much manure on their land, obtaining tonnage at the risk of quality, because beets of such gross growth do not ripen well. Even on the apparently inexhaustible soils at Chino, fertilizers have proven effective. "Green" or fresh stable manure should be plowed under the previous fall; better still, apply it to the previous crop. The main point is to have the soil well filled with available plant food in proper forms.

Elaborate experiments have been conducted along this line in Europe on the old soils of Europe, which Wiley thus summarizes: "As for the relation which the quantity of material returned should bear to the quantity abstracted, it may be said in general that it is desirable to return as much nitrogen, one and a quarter to one and one half times as much potash, and two and a half times as much phosphoric acid as has been abstracted. The greater additions of potash and phosphoric acids have no disadvantageous effects upon the crop. Direct investigations in regard to the relation between the sugar and potash in consecutive crops for many years have failed to give the least ground for a contrary conclusion. But it must not be expected, on the other hand, that increasing fertilizations, especially potash fertilization, will produce proportionately increasing crops, as has been asserted by some.

"The opinion has generally prevailed among beet growers during late years that heavy nitrogenous manuring, especially with nitrate of soda, produces no injurious effect on the quality of the beet. This opinion was based on the fact that in such beets the sugar per cent was only slightly diminished. Nevertheless the quality of a beet may be impaired even with little or no diminution of the sugar content by reason of the increase of the percentage of non-sugars present. It has been shown that heavy manuring with nitrogenous substances greatly injures the quality of the beet for sugar-making purposes."

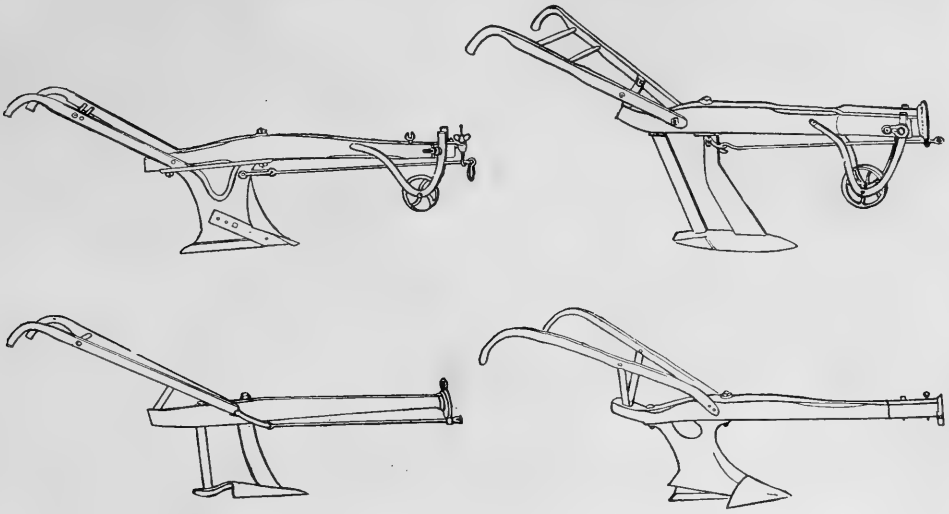
It is true that the beet is not an exhaustive crop, provided all its by-products are returned to the soil, but we fear that this will not be done in America for some years, meanwhile there is danger that failing to thus restore to the soil what is taken from it, farmers may get the idea that the beet will not exhaust the land, and that it can be grown in defiance of the fundamental principles of agriculture. This error should be guarded against by liberal fertilization.

PLOWING.

Immediately after harvesting the small grain, plow shallow (two or three inches) in order to prevent the weeds from going to seed. When this is done, spread the field with stable manure (if any is to be used) and in the fall plow deep. This deep plowing is very important, because the beet is thereby enabled to penetrate into the subsoil without much obstruction, thus preventing it from growing out of the ground and allowing it to extract considerable nourishment from the lower soil. The deep plowing will also give clean ground and will make it ready for early planting and thus insure a large tonnage. The best way to accomplish this is to plow 8 to 10

inches deep with an ordinary plow, follow it with a good subsoil plow that will stir the subsoil to a depth of 5 to 7 inches more, thus giving an open soil to a depth of 14 to 17 inches. This subsoiling is often neglected, but it is essential for two reasons: (1) It gives a deep soil for the beet root to grow down into draining its food from the lower depths, and also preventing the top of the root from growing out of the ground; this makes a smooth conical beet of moderate size, richest in sugar and easily harvested. When the land does not freeze, as in California, this plowing should be done two or four months before seeding.

In case the plowing has not been done in the fall, plow as early in the spring as the ground will do to handle without sticking, for three reasons: 1, Because the sooner the weeds are encouraged to grow, the more of them can be killed before planting the beets; 2, because land plowed while the weather is cool will retain the



OTHER STYLES OF SUBSOIL PLOWS.

moisture much longer than it will if plowed during warm weather; 3, because it is much better to allow the ground to settle as much as possible after plowing and before the preparation of the seed bed, so that it will become thoroughly packed, thus insuring better and quicker germination. In the spring never throw up more than two inches of soil that has not been stirred before; if your soil has never been plowed over six inches, it is better to use a subsoil plow to loosen the ground to the proper depth. These instructions refer only to spring plowing; when good land with deep soil is plowed in the fall it makes little difference how much new soil is turned up, as it would decay in winter through the action of the frost, but on thinner soils, this trouble can always be obviated by the subsoiler.

After spring plowing, harrow, or better, drag once immediately, and then leave the ground as it is until the time to prepare the seed bed, thus allowing the weeds to sprout. If the previous crop was corn, it is absolutely necessary to take the stalks and roots off the ground in the right manner in order to permit of easy and proper

horse cultivation; it will not do to plow the stalks under, however, as it cannot be done effectually, the cultivator-knives bringing them back to the surface once more, and at the same time dragging along with them more or less of the small beet plants. The best way is to remove the mold-board from the plow, which will enable you to loosen the roots without turning the cornstalks under. Then gather them up with a hay rake into piles and after burning as much as possible haul off the remainder.

In many soils in California, a sour clay is brought to the surface by deep plowing, which is injurious to the beet because of its acidity. This should be neutralized by the use of about two tons of lime per acre broadcasted on before harvesting. In California, the spring cultivation of the plowed land is done with an implement furnished with long, narrow teeth that reach to the bottom of the plowing.

MORE ABOUT SUBSOILING.

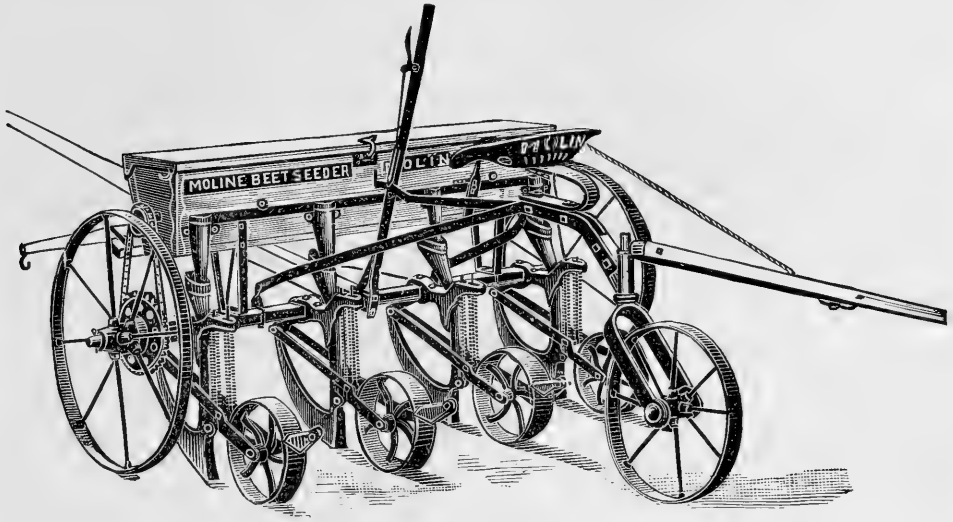
This work is so important, especially in drouthy regions, that more detailed discussion of it is in order.

Subsoiling consists of a loosening or a breaking up of 8 to 20 or more inches of the soil below the depth of ordinary plowing. In true subsoiling the lower layers of soil are not thrown out on top. When the prairies of the west were first plowed, it was sometimes thought desirable to break the sod very shallow; then by following in the furrow, with the plow so made as to throw the comparatively mellow second furrow on top of the first, a layer of loose ground was obtained in which seed could be planted. This so-called subsoiling is in reality nothing but deep plowing, and is practicable only in a new country, or in the breaking up of meadows or pastures which have an exceedingly compact turf. In practice, land to be subsoiled the first time is plowed to the accustomed depth. The subsoil plow follows in the furrow of the ordinary plow, and is run about eight inches deep. If it is thought desirable, the work can be still more completely accomplished by subsoiling crosswise, running the subsoil plow the second time a little deeper than during the first operation. The entire subsoil to a depth of 12 to 14 inches, depending upon the depth of the first plowing, is thoroughly loosened, and so broken up that plant roots can easily penetrate it and rainfall is readily absorbed. When the same land is subsoiled again, run the plow about four inches deeper.

The main benefits derived from this practice are: 1, The upper layers of soil are broken up and placed in a condition to absorb and hold a maximum amount of water. 2, Natural rainfall is taken up and retained until needed by the growing crops. 3, Heat and air are enabled to permeate the subsoil and render available the plant food contained therein. 4, The loosened ground acts as a vast reservoir for storing soil moisture. 5, Stirring the hard subsoil breaks up the capillary tubes and prevents wasteful evaporation. 6, During the wet season the openings made by the subsoil plow allow the excess of water to escape to lower levels. 7, Plant roots are given a better opportunity of development. 8, Such crops as sugar beets, turnips, rutabagas, sweet potatoes, etc, develop more completely under ground, resulting in a higher grade vegetable. If the surface of the field is kept loose by shallow culture, the loose layer will act as a mulch and greatly aid in retaining moisture. Experience and ob-

servation have shown that the season, wet or dry, warm or cold, determines whether crops will be heavy or light. Any treatment, therefore, that will counteract the uneven conditions of a season, even partially, will increase the yield. Subsoiling and surface cultivation have a marked effect in counteracting the disastrous results of drouths. The benefits of subsoiling, however, will depend almost altogether upon the nature of both the surface soil and that lower down.

Where the subsoil is very loose and porous, subsoil plowing may be a decided disadvantage, in that it forms larger passages through which the natural rainfall will escape. If it is not a disadvantage, it often is of no benefit from the fact that the subsoil is already sufficiently loose to retain the greatest amount of moisture. Fields



ADJUSTABLE FOUR-ROW BEET SEEDER.

This machine plants 15, 20, or 25 lbs. of seed per acre in rows 16, 18 or 20 inches apart as desired, covers the seed to an even depth, and firms the soil about the seed. On large areas such a machine is indispensable.

underlaid with a compact subsoil or hardpan, or those which have been plowed at the same depth for a number of years, forming a hard layer at the bottom of the furrow, are the ones chiefly benefited by this mode of culture. This practice on any kind of soil, unless it is hardpan, would obviously be unnecessary during seasons when rains are sufficiently frequent to furnish the necessary moisture for growing crops. During wet weather the operation might result in a puddling of the soil, to its great injury. It is only during very dry seasons when its full benefits would be seen, but for the past 10 or 12 years in the most prominent grain and vegetable producing states, there has occurred in the summer or early fall a drouth which very materially shortened the crop. So true is this, that farmers and gardeners in states comparatively free from severe drouths have begun to seriously consider some method of bridging over this disastrous period, especially injurious to the market gardener and fruit grower. In practice it has been found that unless the soil is unusually compact,

treatment once every three or four years is amply sufficient. With increasing drouths, however, it may be found desirable to subsoil every two years. The work is most profitably done in the fall, as this gives an opportunity for the land so treated to absorb the fall rains, winter snows and any moisture which may be precipitated before spring plowing is possible. This is specially true in parts of the far west, where winter irrigation is practiced. The streams there during early fall or winter usually supply sufficient water for irrigating, while during the dry season they fail.

Admitting, then, that subsoiling ought at least to be tested, the question of obtaining suitable and most desirable plows is important. The common practice, as before stated, is to follow the ordinary breaking plow with a plow constructed especially for subsoiling, types of which are illustrated herewith. These cost all the way from $10 to $18. They can be obtained of any of the prominent plow firms. One company manufactures an attachment, or rather a subsoiler, which is substituted for the front plow on a four-horse gang. There is no getting around the fact that subsoil plows pull hard. In the case of the gang subsoiler, a good four-horse team takes it along quite readily, but if the ground is especially hard, it would need one or two extra horses. With the ordinary subsoiler, which follows in the furrows of the plow, it is customary to use two horses, but three or even four are more satisfactory.

During the past four years many careful tests with subsoiling have been conducted at American experiment stations and by practical farmers. The results, carefully compiled by Mr C. A. Shamel in AMERICAN AGRICULTURIST, are somewhat conflicting, though only a few were with sugar beets.

In New York and Kansas no decided advantage was obtained. In South Carolina on sandy soils, the effect was not appreciable. In Indiana and Iowa, the practice was advantageous in sugar beet culture, as better formed beets, with a higher per cent of sugar, were obtained. Corn in these two states was not benefited. Practical farmers in Kansas find subsoiling beneficial. Mr Kelsey of Oakland, Shawnee Co, stated to the agricultural board that in 1894 land subsoiled yielded 65 bu of corn, while that not so treated produced only 35 bu. Millet on subsoiled land yielded well; on untreated it was a failure. The effects last about three years. Subsoil one-third of the farm each year. Mr Peckham of Haven, Reno Co, obtained substantially the same results. Experiences in Illinois are somewhat difficult to obtain, as but little work has been done along this line. In general the facts in this state agree with those from Kansas and Nebraska.

The most marked results are reported from the Nebraska experiment station in Lancaster Co, by Prof Lyon. The soil in most parts of Nebraska, and where these experiments were tried, contains very little sand and is made up mostly of silt, or of the ordinary dark mud so familiar to residents of the corn belt. Because of the small amount of sand, the soil compacts quite readily, becoming almost as firm as so much clay. It is well supplied with plant food, and when stirred sufficiently deep so as to take up water, is very productive. Good results from subsoiling were very marked. Land subsoiled four years ago for sugar beets and not treated since, was this season planted to corn. A field not so treated lay alongside. Both were upland, with a gradual slope toward the east, and consisted of a fine loam with considerable vegeta-

ble matter. The results were so marked that the exact row of the subsoiled field could be told, because of its superior excellence. The stalks on the unsubsoiled land were badly dried up and contained no ears, while those on subsoiled land were large, green, and produced a fair yield. Such results are encouraging, and show that with very little extra expense good crops can be raised with less rainfall than is generally supposed. If the effect is not apparent the first season, it makes itself felt in the course of two or three years, the reason being that if very little rain falls after subsoiling, the small amount of moisture sinks rapidly into the soil and is retained there until the plant roots need it. After the practice has been started, the excess of water beyond the demands of the soil continues. Subsoiling is especially adapted to Nebraska, because the annual rainfall is less than in most arable portions of the coun-

A HAND PLANTER FOR BEET SEEDS.

Smaller drills like the one illustrated have been used with satisfaction, but this new No. 5 drill is still better and larger, while so simple as to insure the most even seeding and covering. It can be regulated to drop any desired number or weight of seeds, at varying distances apart, or in hills; is equipped with marker.

try. Added to this is a very dry atmosphere, and periods of extreme heat accompanied by high winds. The following conclusions were reached for Nebraska: Subsoil plowing, although conserving moisture, does not produce it and is therefore not a substitute for irrigation where rainfall is too small to produce crops. Where the subsoil is hard, subsoiling is recommended; when loose it is not profitable and may be injurious. Do not subsoil when wet, as there is danger of puddling the soil, thus leaving it in a worse condition than before. Ground subsoiled in the fall has an ample opportunity of absorbing the greatest rainfall. Subsoiling in spring may be detrimental in extreme dry weather, as the water is partially removed from the young plants by the absorption of the dry bottom soil.

PREPARATION OF SEED BED.

Land that has been fall plowed must be harrowed as soon as the frost is out of the ground and the soil is dry enough to prevent sticking. This work will level the

ground, thereby holding the moisture in the soil, and increase the germination of the weeds, etc. To secure a good crop, it is absolutely necessary to kill all the weeds in the ground before seeding. Here is where most failures occur, and if weeds are allowed to get a start, the cultivation of the crop will involve much unnecessary and expensive hand work. Therefore, to prepare a good seed bed, we advise working the soil four to five inches deep with a pulverizer, or better yet, with a corn cultivator, once lengthwise and once crosswise, making sure not to miss any spot in the field, as it is necessary to loosen any weeds that may have already sprouted. In California this has to be done whenever the weeds may start. Then harrow lengthwise and crosswise to level the soil perfectly and finish killing the weeds. After this, pack the top soil to a depth of two to three inches well with a heavy roller; never use a plank float for this work, as floated ground is never well packed, and will besides increase blowing and washing. The better the soil is packed after the weeds are killed, the better the beet seed will sprout. All the above work must be performed at a time when the ground is in good working condition; that is, not too damp, as the working of wet soil must be strictly avoided. As beet seed requires considerable moisture to germinate, it would also be a great loss to the beet grower to allow the soil during the preparation of the seed bed to dry out; therefore in dry weather or in an average season, the field must be prepared and seeded the same day, this being the only way in which the moisture can be kept in the ground under the usual west conditions—a great feature in crop raising and especially so in beet culture.

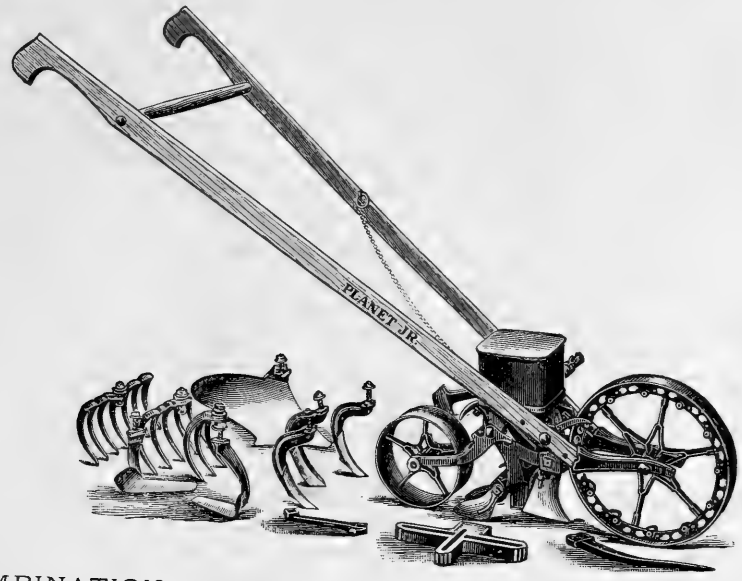
To prevent the soil blowing, which is very disastrous to the small beet plants (in Nebraska, even the best black bottom land will blow, if level and fine, which it must be to secure a good crop), run a light harrow over the field, after rolling but before seeding. This harrow must be very light and can be easily constructed and without much expense by using 2x2 pine pieces for the beams and large nails for the teeth, only letting them project below the beams 1½ to 2 inches. This harrow must simply scratch the soil (not over half an inch deep), thus giving a rough surface, which will prevent blowing except on dry, sandy soil, on which, for this reason and some others, sugar beets should never be planted. The soil must not be loosened again by a deep harrowing, as this would injure the germination.

There is a tendency to neglect some of these various preparations of the soil, but except on certain lands particularly adapted to the crop, every step above enumerated is essential. Too much care cannot be devoted to the preparation of soil and seed bed, for upon it success largely depends. Even if the season is unfavorable, the crop will do enough better on a well-prepared soil to pay for the labor, while in a favorable season, this work will yield a handsome dividend. It will be seen that such preparation is directly contrary to the careless way in which the land is usually worked for field crops. Right here is where beet culture differs from that of almost any other crop. It involves intense farming of the highest type. Not one of the old market gardens about New York, Philadelphia, or other eastern cities is more carefully worked than the sugar beet requires for best results.

SEEDING.

To secure a full yield, it is absolutely necessary to have a good stand. It is much easier to thin out surplus beets with a good stand, than to have to plow under the

entire patch and replant it in case of a poor stand. It is desirable that when the plants come up they should nearly touch each other, but there is no necessity of overcrowding, as this occasions extra labor in thinning out. Or the seed may be planted at a distance of three or four inches in the rows in groups of three or four seeds. Formerly only 10 or 15 pounds of seed per acre was sowed, but American experience during the past six years has emphasized the importance of sowing at least 20 lbs of seed per acre. Then, should the weather be dry, the best seed will come up first and there will be enough for a good stand. On the other hand, should a crust be formed on the field after a heavy rain, one plant would help the other to break through the



COMBINATION PLANTER AND CULTIVATING MACHINE.
This No. 4 machine also plants well, and when through with for that purpose, can be used as a whee hoe, cultivator, rake or plow, by using the appropriate parts. Its advantages to small cultivators of limited means are obvious.

ground. It is easier to do a little extra thinning than to replant. If seeding a small patch by hand, less seed will be required if the work is done carefully.

Almost any garden drill can be adapted to sowing beet seed, but for larger fields the four-row horse drill is used. Seeders made especially for this purpose, seeding four rows at a time and dropping the seed continuously in rows 14 to 19 inches apart, (according to the fertility of the soil) will plant 10 to 12 acres per day. Never plant over three-fourths of an inch deep, but see that the earth is well packed around the seed by the press wheels attached to the back of the drill, because by pressing the surface the necessary moisture for germinating in a dry season is drawn by capillary attraction out of the deeper soil. The heavier the soil and the earlier the planting, the shallower must the sowing be in order to prevent the seed from rotting in the ground. The deeper the seed is planted, especially in heavy soil, the weaker the

plants will be if they come up at all. Therefore avoid deep planting, which invariably gives a poor stand. The least covering of moist earth, well packed about the seed, is sufficient to sprout it.

The rows may be 10, 12 or 14 inches apart if it is intended to weed out by hand; or 18 to 21 inches if the horse hoe is used.

Time for planting is when the soil is warm enough to germinate the seed. This is usually about two weeks or so earlier than the average farmer would think of planting corn. In California it may be any time from January to June, in the central west from April 20 to May 20, further east May 1 to June 1, and for the south March 1 to May 1. No hard and fast rule can be laid down; the intelligent observer can judge from the season and condition of soil. The young plants should show in 7 to 21 days, according to the season. If the stand is poor, cultivate it out and reseed the whole field; or replant the poor spots.

Parties growing a large acreage and not having very much help, will do well to plant the crop in sections, at intervals of one week apart, in order to gain more time for thinning; however, do not plant too late, for in that case the beets will not be strong enough when the dry season sets in, and will therefore suffer from the drouth, while the earlier and consequently stronger plants will thrive well and a heavier and better crop be insured. You had much better hire help during thinning time than to plant too late.

If beets are planted at great distances apart, they become large in size and freely absorb salts from the soil. To avoid this it is necessary to plant close together, thus dividing the available salts in the soil. Sugar is largely formed in the beet from the air through the leaves, and these should be many in number and of fair size, hence it will not do to overcrowd the plants.

CULTIVATING.

This work is performed with one-horse cultivators, which work one, two or four rows at a time. If after sowing, a heavy rain should cause a crust to form on the field, the light harrow previously described to prevent soil blowing is recommended; but this only in case the seed has not germinated, as otherwise it would be better to run the cultivator over the field, following the rows, which can be done easily before the seed is up, as the marks of the press wheels can be plainly distinguished. This work, however, can be better done by hand hoes (11 inches wide; see Hoeing). As soon as the beets break through the ground and the rows can be followed, the cultivation must begin, the earlier the better, not only to destroy the weeds, but to loosen the soil, which permits the air to penetrate, thus forcing the growth of the beet and improving the quality.

It is very important to kill the weeds before they get above the ground, or at least before they become well-rooted. This can be easily accomplished by cultivating the field with the flat shovels every eight or ten days, care being taken to set the knives as close as possible to the rows, and never over two inches from the rows as long as the beets are small. As the beets grow older, however, the shovels should be run gradually farther away from the beets, and also deeper, until the leaves meet in the center of the rows, by which time the cultivation should have reached a depth of

6 inches, and should then cease, as the beets are ready to lay by. Besides destroying the weeds, this repeated cultivation prevents evaporation from the deeper soil, and secures a good and healthy growth. Never hill the beets, as level land keeps the moisture best.

Keep the horse cultivator going whenever weeds appear, or a crust forms, until the beets have grown so large as to prevent this work, when they may be " laid by." In Utah and California, four cultivations and one hand hoeing, besides one spacing and thinning, is all the crop requires, but in Nebraska winds and drouth may necessitate more work on the crop. Frequent stirring to a depth of two or three inches is one of the best means of preventing loss of moisture from below during a dry spell. This point cannot be too carefully observed whenever a drouth threatens, and if this cultivation is well and frequently done, the crop will stand quite a severe drouth without much injury, if the ground was previously prepared as described on Page 83.

Hoeing has been rendered more effective and less expensive by the use of the various horse hoes and cultivators illustrated, but the use of these machines is to be supplemented in the field with the hand hoe. Great care must be exercised in using any cultivating machine, for if the setting up and use be not carefully looked after, the weeds will not be extirpated, while whole rows of beets may be cut down. Frequent hoeing and cultivating cannot be too highly recommended, for, as they say in Germany, "sugar is hoed into the beets." In Knauer's experience (Germany) a plot hoed once yielded 7 tons of beets per acre, twice gave 8 tons, three times gave 10¼ tons, four times gave 12½ tons, while a field hoed five times yielded over 13 tons of dressed beets per acre, thus doubling the yield over the plot hoed only once.

It will be seen from the foregoing that flat culture and rows is the universal rule at present in America. Mr Lewis S. Ware, editor of *The Sugar Beet*, states in that paper for January '97, illustrating a French machine for harvesting beets in hills: "We have on many previous occasions urged that hill cultivation should be given a fair trial; it enables the tiller to get from beets most satisfactory results. The objection, evidently, is that special agricultural implements are needed. In Europe, the rows on hills are either single or double; when single, the harvesting with ordinary plow may give good results, but it is very much more expensive than it would be with a special double row harvester. When in single rows on hills the distance between rows is 21½ to 23½ inches; when in double rows on hills the distance is 9 to 11 inches, while the hills are at distances which vary from 27 to 31 inches. There can be no doubt as regards the yield in hill cultivation; it is equal and, in many cases, is superior to flat cultivation, as the roots in growing find less resistance to overcome and have their plant food within easy reach, and through the soil there is a better circulation of air; furthermore, there need be no evil effects from badly drained or damp soils which, under ordinary conditions, are almost worthless."

This point is worthy the attention of American growers, though the fact that flat culture and drills have thus far been universal, indicates that they are generally satisfactory. One thing is certain, that hilling should not be practiced on dry and warm soils, for there it can only work harm. Hilling up may be of benefit on cold and wet soils, but these are properly treated by drainage. Of course if the soil gets washed

away from the plants, the earth should be drawn up about them, as that portion of the beet that shows above the soil is of inferior quality.

HOEING.

The first hoeing, which is very important for the growth of the small plants, must be given with an ordinary 11 inch hoe between the rows, going 1½ to 2 inches deep, and as soon as the beets break through the ground, or if crust is formed, as soon as this occurs, following the press wheel marks.

As the ground will have become packed during the bunching (or spacing) and thinning, thus preventing proper circulation of air, and the young plants, moreover, will have become weakened by their disturbance; and for the further reason that it is cheaper to do it then, the second hoeing should be given with a 7-inch hoe the day after the beets are thinned, and never later than a few days after, care being taken to kill the weeds out close to the plant, but in such a manner as not to loosen or injure the beets. As the horse cultivator only loosens and clears the ground between the rows, the hoe must perform this work between the different plants. This hoeing should be 3 inches deep. A similar hoeing may be necessary twice after this, the last depending upon the freedom from weeds, also upon whether the ground is loose enough to enable the roots to grow. Both of the last hoeings should be as deep as it is possible to make them without injuring or loosening the plant. Under ordinary circumstances no work should be necessary in the field after 80 days from the time of planting except the final and deepest horse cultivation.

THINNING OUT.

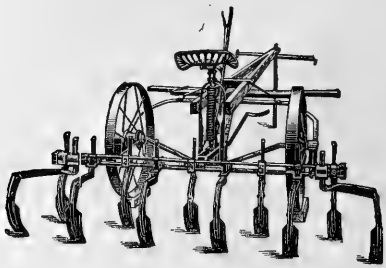
Care should be exercised in doing this part of the work, as it is the most important of all the cultivation and care of the crop. It can only be neglected at the expense of yield and quality of crop. It is very necessary that this should be done just at the right time, and the sooner it is done the better for the growth and yield of the crop. As soon as the beets have four leaves, they should be thinned, and must not remain longer than one week without thinning, as the roots will entwine around each other if left longer, and make the thinning detrimental to the plant that is left. To perform this work, the beets should be spaced or bunched (directly after a horse cultivation) with an ordinary 6-inch hoe, cutting 6 inches of beets out and leaving a 2-inch bunch, containing from three to six beets. After the beets are bunched, the healthiest plant in each bunch is selected by the thinner to be left standing, his finger is placed firmly against it to prevent its being disturbed, and the other plants are pulled out by hand, together with all the weeds nearby. This operation will leave one strong single plant every 9 or 10 inches, and the ground should be pushed up well around each, but not packed. Of course, it is better to select the strongest and most thrifty plant, even if it is not at the regular distance, than to chose a weakly or spindling one at just the right distance.

If thinned when only four leaves are on the plant, the top soil is still moist, and the beets left have no difficulty in taking hold and growing with renewed vigor, but the disturbance occasioned by thinning a few days later is not so easily overcome. The top soil is then dryer, and the young beet receives a set back that will certainly

HOEING AND THINNING BEETS.

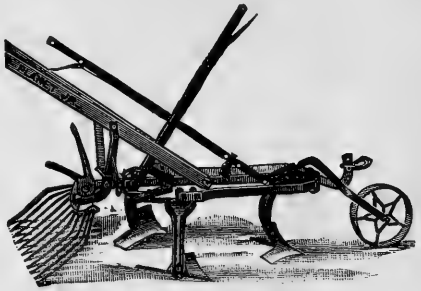
Willett Farm, Grand Island, Nebraska.

affect the yield. Where weeds or insects are not to be feared, the spacing may be done a few days before thinning. On the other hand, if there is any reason to fear loss of the young plants, it is more prudent to wait a little longer before doing the work of spacing, and in this case thinning should follow spacing without any interval. If the land is very rich, the final plants are left as near together as 6, 7 or 8 inches, while in Utah, under irrigation, the plants are even thinned to 4 inches. The distance apart at which the beets are left depends not only upon richness of the soil, but upon the probabilities of its having sufficient moisture. In the rich moist land the beets can stand closer together than on dryer and lighter soils. By spacing with a hoe a more regular distance is secured between each beet, and all the weeds in the row are destroyed at the same time; the crust is also broken up that has been formed by the pressure of the wheel of the seeder, and it removes any seeds from the row that may not yet have germinated, thus avoiding, when harvest time comes, the appearance of a lot of small beets that had grown up from these seeds. This spacing with the hoe is also apt to increase tonnage and percentage of sugar.



PLANET JR. TWO-HORSE CULTIVATOR.

The leaves of the plant are the means through which it obtains most of its sugar. This substance is composed of carbon and oxygen, both of which are mainly taken in by the leaves, the former as carbonic acid. Mr Ware, in his great work on the sugar beet, summarizes experiments by himself and others to show that the saccharine content of the beet improved with the number and weight of its leaves. "Each leaf has apparently communication with a given portion of the beet, and supplies it with the nourishment it requires. The outer leaf corresponds with the inner portion of the root; these representing the older leaves, we may conclude that they have furnished the larger portion of the saccharine elements. During the growth of the leaf, the root increases but comparatively little in size, and as soon as completed, the contrary action takes place. Evidently, the greater the size of the leaves, the larger the amount of the elements they are able to abstract from the surrounding air, and the total weight of the leaves is, up to a certain period, greater than that of the root."



ANOTHER FORM OF CULTIVATOR.

This admirable Planet Jr. tool as a beet horse hoe, has a one and three-fourths inch cultivator tooth, two six-inch hoes, a twelve-inch special flat sweep, and a pulverizer. The latter is a very useful attachment, leveling and fining the surface and killing small weeds.

The smooth and tapering shape of the root desired depends mainly upon the soils where it grows and the preparation the soil has received. The variety of seed used has of course some influence on shape of root, but the most desirable seed for this

WEEDING OUT THINNED BEETS FOR THE LAST TIME.

Photograph of 40 acres of beets at East Norfolk, Nebraska. This plot of beets is a perfect stand, and in another week will be "laid by," not to be disturbed until harvest time.

purpose will not give roots of satisfactory form on an unfavorable and poorly prepared soil. It is senseless to blame the seed for faults in the soil.

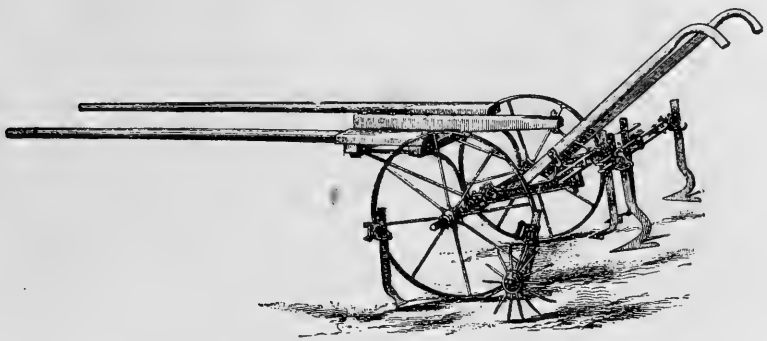
IRRIGATION.

Utah has solved the problem of growing beets by irrigation. Her experience teaches many practical lessons that are being heeded in drouthy or irrigation regions. Too much water, applied too often or at the wrong times, is bad for tonnage and quality. Great damage is done to many fields of beets by inexperienced farmers flooding the land and allowing the water to stand about the small plants, then neglecting to cultivate until the soil has baked. Even in Utah, it is still recognized that the management of irrigation to produce the best results is a delicate matter, and not yet fully understood. Untimely irrigation may utterly destroy the value of the roots for sugar making, and the necessity of varying the application of water according to the nature of the land, in order to secure good results, implies the exercise of much judgment and experience in the matter. But with due regard to all these alleged disadvantages of irrigation, it is the universal judgment of Utah beet growers, after six years' experience, that they are far outweighed by the benefits of irrigation. The production is more certain, and the harvest more safely assured, than where the caprice of heavy rains or excessive drouth has to be contended with. The results are always more certain where irrigation is necessary and this is the greatest stimulant to proper methods in applying water.

Mr George Austin, field manager of the Utah Sugar company, has had more experience than any other man in growing beets by irrigation. Mr Austin says: "After the thinning is done we run a cultivator drawn by a horse through the rows, but great care must be taken not to cultivate too deep or hill up the young plants, as they require all the air and sunlight that it is possible for them to have. After the first cultivation we generally hoe them the second time to clean out all the weeds in the rows and remove any surplus beets that may have been overlooked at the time of thinning. By this time the beets should be far enough advanced to commence preparing for irrigation. This we do by using the same cultivator, attaching a small 6-inch furrower on the rear end, and we cultivate every other row, leaving a nice little ditch of sufficient size to carry the water without flooding the beets. The second watering we alternate the rows—this method usually gives enough moisture each watering, but this kind of irrigation, however, depends entirely on the slope and condition of the land. If the land has much of a slope, and is inclined to be a light, sandy loam, it may be necessary to water each row every time you irrigate during the season, but the latter is an exception to the rule with us.

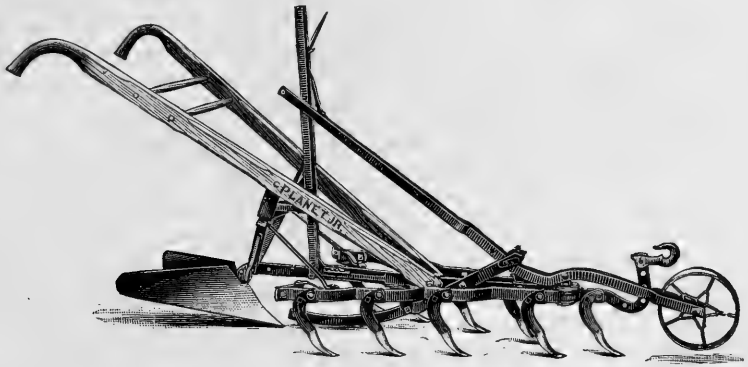
"We never commence irrigating until the beets show they require moisture, (usually letting them suffer a few days), and by so doing it always gives us a nice shaped, long, tapering beet. If the first watering is applied too early we usually have a short, spriggy, undesirable beet. Too much manure or alkali will have the same effect on sugar beets. We generally have to make cross ditches on our beet fields on about every 20 to 30 rods, depending upon the slope and nature of the land. If we run the water farther than this it usually saturates the upper part of the field too much, before the lower end gets sufficient. Great care must be taken in turning the

water on the beets not to force too much into the furrows, causing it to flood or overflow, and this must be avoided if possible. Therefore it is essential to select land for this crop, as much as possible, with a nice slope. We always cultivate the rows after each watering as soon as we can, cultivating them from 5 to 6 inches deep. This allows the beets to develop, and also helps to retain the moisture much longer than it would



FREMONT SUGAR BEET CULTIVATOR.

This Nebraska invention is the result of several years' work in the beet fields of that state. The machine is simple, light, compact and easily adjustable for either deep or shallow cultivation. The four spiders provided are used in case the soil becomes crusted on the surface, thereby preventing the beets from showing through the ground. There are four knives that are used in cultivating the beets when very small. These are different from any used heretofore, and are so shaped as to permit the party handling the machine to work very close to the plant without danger of covering the plant with dirt. The four small shovels are used for the deeper cultivation, and the two large shovels are for the final and deepest cultivation.



PLANET JR. BEET GROWERS' HORSE HOE.

This machine has been perfected by Utah experience, and is very popular there. The teeth loosen the soil thoroughly without throwing earth on the small plants. The little plow at the rear is the "irrigating tooth," to make a clean furrow through which the water will run for irrigation.

otherwise. Care must be taken all through the season not to hill up the beets, or break off the leaves. We generally water our beets two to four times during the season, and it usually takes about 20 to 30 days after the last watering before the beets are ready for harvesting."

Mr Morgan Woodhouse, another Utah grower of experience writes: "My idea is to let them go as long in the spring without water as you dare, say until the bottom

leaves wilt down and the tops begin to change from a light or yellowish green to a dark green. After the first watering they should be kept wet. I would not be in favor of going to an extreme, but I would not allow them to get dry if I could help it. The length of time between waterings should vary, according to the land, from 8 to 14 days. The last watering should be about the last of August or the first of September."

Another expert, Mr Samuel Taylor says: "I do not believe it is good to irrigate too soon. Let your beets get up and get them thinned, letting them have a pretty good start. When the lower leaves begin to wilt and the tops turn a dark green, the water should be first applied. Of course when you start you must keep it up. Three or four waterings will make a good crop of beets. Four are better than three, and if you can get four good irrigations on a crop of beets I am satisfied they will mature and make a good crop. With respect to the last watering; one year we were told to stop watering too early and we lost a great many beets by it. I would water the last time about the last of August, if watered up to this date the beets will be all right."

In Nebraska it is felt that proper irrigation will often insure the crop, but experience has so far been limited. Mr F. Wietzer, field manager for the Norfolk factory, summarizes the matter for this work as follows: "We have taken much interest in irrigation of sugar beets. Last year there was raised 90 acres by irrigation, and the results were very satisfactory, as well in quality as quantity. Beets should never be irrigated until they show actual need of it. No water should be put on them as long as there is a natural supply of water in the ground, for too much water is almost as disastrous as not enough. After you have once commenced putting water on land, it dries out more quickly than before and will require watering the second time. The number of irrigations that a crop requires during the season depends entirely upon local surroundings, nature and condition of land. The first irrigation should not be before the middle of June, and no water should be applied after the first week in August. Beets should never be irrigated in the fall, for irrigating at that time will bring forth new tops and give the roots a second growth, which is disastrous to the quality. A very advantageous method of irrigation is this: When the spring is very dry, to soak the land from the irrigation ditches, and then as soon as the soil is dry enough, prepare seed bed and plant seed."

Mr Granger, field manager of the Utah Sugar Co, spoke of irrigation at length in his address before the Pecos valley beet growers in New Mexico. Among other things he said: "As soon as you have commenced irrigating, see that the beet is kept supplied with sufficient moisture to keep it thrifty. It will take thirty days from the last irrigation before you can harvest, usually; on very sandy land twenty-five days, on clay land thirty days. This delay is necessary because, when you are through irrigating for the last time, the beets are nearly through growing and the sugar is forming. When given an irrigation, the sugar in the beets will go down for fifteen days, and it will take a little longer to get back again. A great many people ask me how many times they shall irrigate. I cannot tell them without seeing the field. When the leaves wilt down in the middle of the day it is not so bad, but when they stay wilted in the cool of the evening, give them a drink. Let them suffer a little for water in the fore part of the season; it will force the taproot to reach down for moisture. In

irrigating beets, we take every other row, and find that the water when run slowly will irrigate both. Then we alternate the next time, and run water through the other rows, giving the beets moisture on both sides. After every irrigation cultivate as deep as you can, practically eight inches. It is necessary to loosen the ground around the beet so that it may have a chance to develop. To do this we take a little A-shaped sweep, with the point running into the ground, and all it does is to lift the ground a little, but it loosens the soil around the beet. In Utah, our water is run to us in canals and ditches in which we are all interested, and have turns to use it. Only two or three nights before I left home, I found a water notice at my house, stating that the water would be given me at 8 that evening and taken off at 4 in the

THE MOLINE BEET CULTIVATOR

Can be used to work either four or two rows. The gangs are so adjusted that they can be handled with ease, and the shovels are so adjusted as to be run right up close to the beets. This cultivator is widely used in American beet fields.

morning. At 4, my neighbor is there, and he takes it. We never have more than 30 minutes to the acre in Lehi, and sometimes it is cut down to 15 minutes, during which the water is allowed us."

William Bone, Jr, another very successful beet grower for the Lehi concern, says: "I think beets can hardly have too much water at certain times, which can only be judged by practical experience. A great deal depends upon the season and the land, too. I would not water them until they show that they need it the first time. In naturally light land they will stand watering pretty early. They should have at least two good cultivations before they are watered at all. In regard to the last watering, my idea is with them the same as with any other crop. If you let any crop wither and die, it is not good for anything. It naturally loses its strength and vitality.

Water will not stop the beets from ripening, that is, unless the land is wet and clayey, and of course a person should know better than to water such land late in the season. Beets that have been well watered will not be affected nearly so much by the late storms as those that have not been well watered. My experience is that beets need some alkali, but I do not think that very strong alkali land is good for them. There is naturally more or less alkali in all our land, unless it is the light, loamy soil. Beets like manure. Even here in Utah, all our land needs manure for beets. Of course a person can go to an extreme, but as a rule all our lands need manuring. There is one thing more about preparing land for beets: I am sure that many of our people tramp their land too much. Some of it becomes packed very heavy before the beets are put in. After the beets have come up the land cannot be cultivated too much."

We may add that frequent and thorough culture is the best substitute for irrigation. With it, the beet will stand quite severe drouth. During the great drouth of '94, in the valley of the Platte, Nebraska, beets stood the drouth better than corn did, for the subsoil is of sand and the water is only 10 to 15 feet below the surface of the ground, so that the roots of the beets can almost penetrate to the water.

HARVESTING.

It requires about four and one-half to five months after planting to procure ripe beets, although in California the time varies from 120 to 160 days. After they have been in the ground that length of time, and the outer leaves turn yellow and die down, it is an indication that the beets are ripening. The maximum of sugar and purity is usually obtained during the month of October over much of the country where ordinarily severe winters are experienced, but in the Southwest and California, maturity on moist and late lands may not be reached until considerably later. The factory usually samples several fields before advising growers to enter upon the general harvest. As the beets increase in tonnage mostly during the last six weeks of their growth, the harvesting with full force should not be started too early. On the other hand, the beets must be out of the ground before hard freezing weather, as alternate freezing and thawing injures the sugar content. In case of a severe freeze before harvest is completed, it may be best to leave the balance of the roots in the ground for a few days until normal weather is restored, as the quick thawing out of the beets might seriously impair their sugar content.

The beets may be plowed loose from 8 to 10 days before removing from the ground, using a plow with a thin blade, which splits the soil between the rows. Instead of the share it has a narrow blade in the nature of a subsoil point, enough to carry it deep into the ground. The use of the plow avoids the injury to the beet caused by spades, hoes or shovels, and it is then easier also to remove the beet plant from the hard soil. Treated in this manner, the roots ripen and gain in weight and sugar; the earth adheres less to the root and can be shaken off with ease. In Nebraska, a two-horse puller is used (Page 105) which loosens the beets, but leaves them in the ground. Whatever method is employed, the tops are taken hold of by boys, who pull the beets and throw them into piles. Another set of boys cuts off the tops with a beet knife, and for this purpose, the point of an old scythe set in a handle is about as good a tool as one can use, or a corn knife. The topping is best accom-

READY FOR THE BEET HARVEST, NEBRASKA.

plished by a deep, straight cut across the beet without whittling, including the base of the rough portion of the top, from which the leaves grow

It is important that the top of the beet be cut off down to the neck so as to include with the top all that portion of the beet to which the stems of the leaves have been attached. "The object of removing this portion of the beet is to prevent the mineral salts, which have accumulated in large quantities therein, from entering the factory. These mineral salts exercise a very deleterious influence on the crystallization of the sugar, and therefore should be removed. They are well fitted for fertilizing purposes and are of more value when left upon the soil than when removed to the factory." These tops of the beets, with the attached leaves, are admirable for fodder.

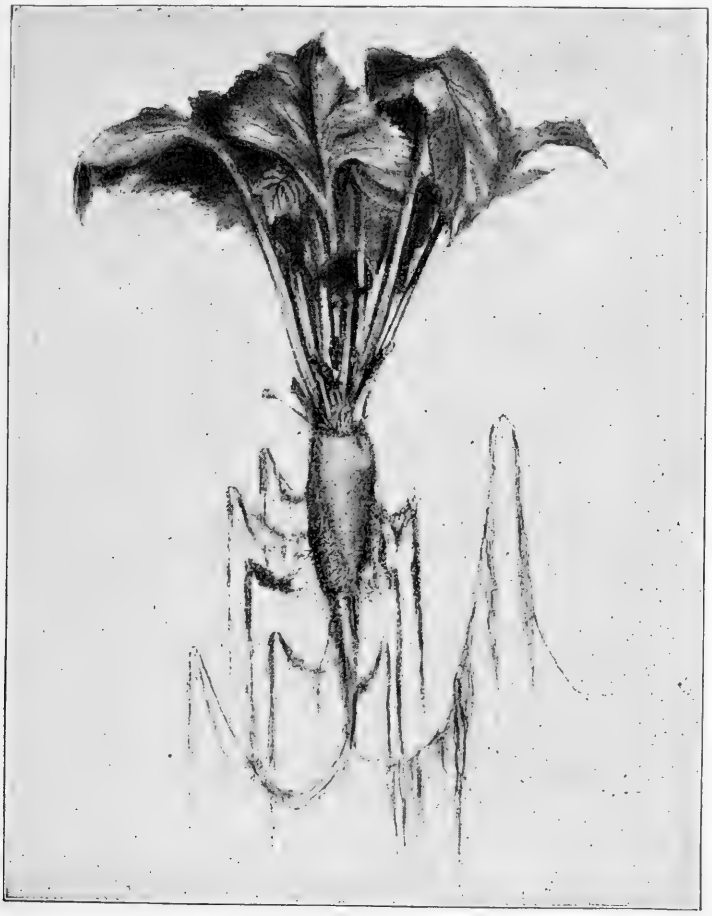
Another important point in harvesting beets is to have them as free from dirt as possible. When beets arrive at the Nebraska factories, an average 50 lbs is taken from each load. They are then thoroughly washed and examined to see if properly topped, then weighed again, the loss determining the tare. The greater the amount of dirt on the roots or the more improperly they are topped, the larger is the loss in weight or tare. The farmer not only has to stand this loss but he also bears the expense of hauling and handling this unnecessary dirt. Not only that, but the dirt adhering to the roots is the finest part of the soil and very often the richest and best portion, and in a few years, a surprising amount of soil is thus taken from the land. Some careful beet growers not only try to deliver beets as clean as possible, but instead of returning with their wagons empty, load up with the waste deposited from the washer at the factory, which contains not only the rich earth that has been washed from the beets, but also the tip ends of roots, etc, all of which possess fertilizing value of importance.

Several harvesting machines to both dig and top the beets have been tried but up to the past season, all have been discarded. Numerous clever and practical minds are at work on the problem and it is probable that a satisfactory machine to take the beets from the soil and top them will soon be perfected. There are several very successful machines for simply digging or plowing out the beets, several of which are shown in the accompanying illustrations.

The beets, after being topped, are then thrown into wagons, covered with sacking and hauled to the factory, or stored in silos in the ground. In delivering beets from the field to the factory, wagons hauled by horses or mules are usually employed in this country. It is a question, however, whether a more economical method is not possible, when the factory is in the midst of the beet fields. In this case, a movable railway with light rails and sleepers, that could be moved quickly and cheaply as the beets were harvested, would enable one horse to draw a car containing more beets than the ordinary two-horse wagon will carry. An overhead trolley upon which baskets of beets are drawn by ropes might be used, or on a large scale, where a factory is equipped with electricity, a movable overhead trolley employing electrical power to push the car along, might be feasible. Beets cannot be hauled by wagon more than from 4 to 8 miles without its costing more than the traffic will bear. Of course

where they are delivered to the railroad, the loaded freight cars are run by a spur track direct to the factory yard or shed.

Mr Ware says that "A great mistake made by many farmers is not to cover their beets as soon as pulled, for if left on the ground they may lose 6 per cent moisture in 24 hours. Place them in silos, if possible at once, until needed at factory. The loss of moisture can attain within a few days 20 per cent, the quality of the juice is not



THE MATURE SUGAR BEET.

Plant 150 or 160 days old, Vilmorin variety, with its root system, about one-twelfth natural size. This plate from Bulletin 44, Nebraska experiment station, evidently reduced one-half from larger plate in Bulletin 27, Division of Chemistry, United States Department of Agriculture.

improved, changes take place, and the manufacturer frequently has considerable difficulty in working such beets. The farmer loses, so does the manufacturer. A neglect of this kind is more serious than most American farmers realize."

STORING BEETS.

In the mild climate of California, the beets are dumped in large sheds at the factory, or are simply left in huge piles outdoors. The loss in sugar content seems to be

comparatively slight for a few weeks, and the beets are worked up before material injury occurs.

In the colder climate of Utah, where the temperature goes as low as in any part of the United States, it was formerly thought that the beets must be carefully stored in expensive silos or sheds. Hence when the Lehi factory was first built, the five frost proof beet sheds shown on Page 111 were built—of lumber, the walls being lined with straw. Each shed is 500 ft long and 26 ft wide, constructed with a sluice in the center so that the beets can be shoveled into it and brought to the factory by water, which is not only economy of labor but it gives them a thorough washing.

Manager Cutler writes: "We have discovered since then, that frost is something we are not afraid of, providing that our beets are brought here in a perfect state. We have erected since then several platforms, one of which has sides to it, but the top is left entirely open. It is 500 feet long by 34 feet wide, and will hold fully 3000 tons of beets. We also have other platforms with a sluice in the center, but without any sides, and we use a movable railroad track—as fast as the beets are unloaded the track is moved further out, until we have an enormous pile resting on the plank or platform as above described. This system has worked admirably, and the best beets we had stored were those that were left entirely open to the weather. The system of storing in large open piles has proven satisfactory under our conditions. We have stored some 6000 tons of beets in piles on the bare ground, sluices having first been constructed to carry the beets by water to the factory from the piles. When the frost came(and we had the temperature as low as 10 degrees below zero in December, 1896,) it froze over the surface of the stored beets to the depth of two or three beets, but there was enough vegetable heat generated in the large pile to keep the beets in good condition and we have never yet lost a beet from frost. We are more afraid of the sun's rays than we are of frost. There was some loss of sugar in the small outside layer of beets that was frosted, but it was not enough to be of much importance, and the loss is infinitesimal compared with the expense of storing in sheds."

The two past seasons are the only ones in which this method of storing in large open piles without protection from the weather has been tried in severe American winters. The author is not yet ready to recommend this method, as a general practice, in the severe cold weather and alternating freezing and thawing of a northern winter in the middle or eastern states. It should be carefully experimented with under the conditions in each locality.

This plan is not feasible on the farm. Even in Utah, the factory authorities have preferred that the farmers store their late beets in the field according to the system much in vogue in Europe. When this is done, the factory pays the farmer 25 to 35c per ton for thus storing the beets and delivering them when wanted. For this purpose, the Utah plan is to dig a few rows of beets, then to run a tongue scraper down the field, making a shallow trench. As the beets are dug and topped, they are thrown into this trench and covered with leaves, a furrow is plowed down each side to drain off the water, if it should storm, and the leaves are covered with a little dirt to keep them from blowing off the beets. The beets thus stored have generally come in good condition. Some were frozen, but as a rule, the farmers feel that they can store the beets and deliver them at almost any time within two or three months in good condi-

tion. At the same time, experience at the Utah factory is rather against trying to make too long a run, owing to the possibilities of loss in quality as well as other chances.

Siloing in the field has to be more carefully done in Nebraska, and after six years' experience the Norfolk factory recommends this plan, which is a modification of European methods: "In the first place do not harvest your beets until they are ripe, as green beets do not keep as well in silos as ripe ones, and besides should you harvest when too green they might not contain the necessary 12 per cent of sugar with 80 purity. In an average Nebraska season no beets should be siloed before October

THE WALKING BEET PULLER.

This homely device is much used. There are several varieties of it. The tool is quite popular in lieu of a better one.

15th, and if the weather is warm it would be better to wait until the 20th, but in no case should the beets be allowed to remain unharvested (and not siloed) until the ground freezes. Frost-bitten beets will not keep; therefore all beets that you silo must be free from frost and be covered up the same day that they are harvested.

"We would advise making five to seven silos to the acre, placing not less than two tons in each silo. When ready to silo, lift the beets from 40 to 45 rows with a horse harvester. These loosened beets must then be pulled out of the ground by hand and thrown in piles. It is advisable, in case the strip you have lifted contains 45 rows, to make a pile every six rods the length of the strip, and as this section of the 45 rows

is about four rods wide and six rods long, each silo would thus contain the beets from 24 square rods (about one-seventh of one acre). To prevent unnecessary handling it is advisable to first pull out the beets from the middle of the marked 24 square rods, placing them in such shape as to make a vacant place in the center about one rod wide and two rods long, then to pull the balance of the beets, throwing them into a windrow close to and surrounding this vacant spot. When this is finished, top the beets (at the base of the bottom leaves) with one stroke of the knife and throw them in the vacant place, making a pile four feet wide and not over three feet high, the length of the pile depending entirely upon the yield. After all the beets are topped and piled up in proper shape, cover the pile with six inches of dirt, being careful not to have any leaves or straw on the beets or mixed with them, and also to leave wide open a hole one foot in diameter, every five feet on top of the pile (at least two in each pile), for ventilation, as beets will sweat some after siloing.

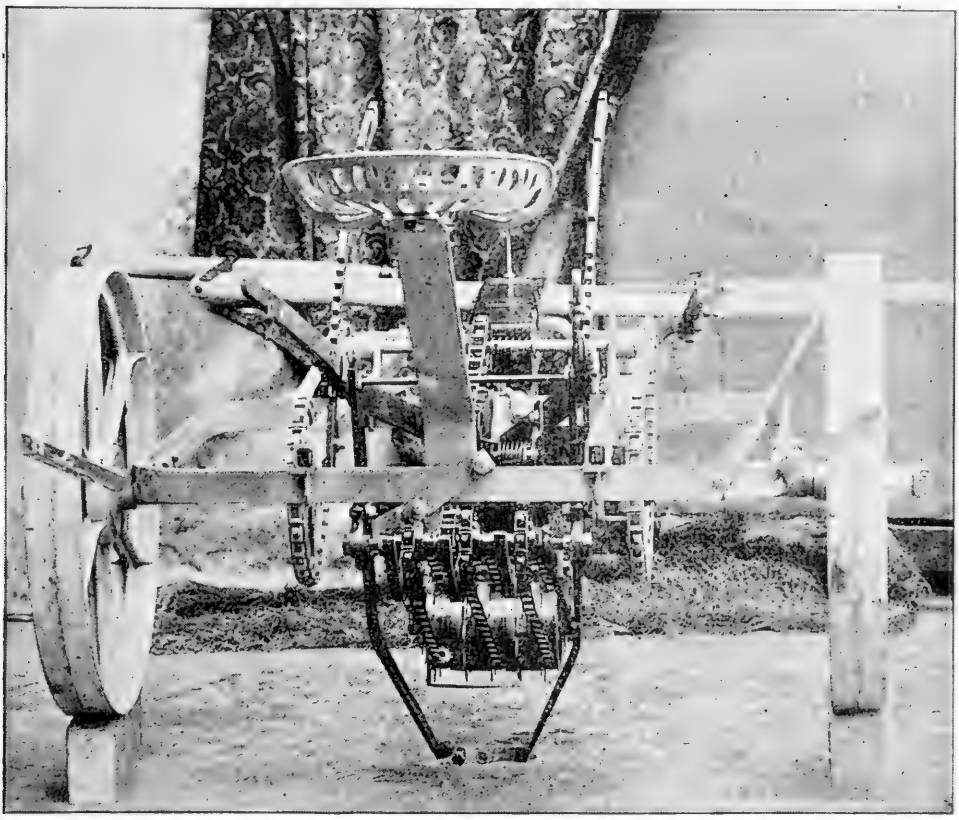
"It is generally advisable not to put much more than six inches of dirt over the beets in October, but to keep them free from frost you should cover the silo before the weather gets cold, say about ten days or two weeks after harvesting, in any case before hard frost sets in, evenly, with five to six inches of loose straw, leaving the ventilation holes uncovered, and place about two inches of dirt on top of the straw to prevent it from blowing away and for the purpose of packing it, as when well packed it will best keep the cold air out of the silo. Thus the covering will finally be composed of six inches of dirt, two inches of packed straw and then two inches more dirt. In an ordinary season such covering should keep your beets from freezing, but should there be exceptionally cold weather you might find it necessary (in case we have not ordered all your beets delivered to the factory by that time) to cover the remaining piles with some long manure. As soon as the covering of silo freezes two inches, shut the ventilation holes with dirt and then keep them shut."

Formerly the farmers were opposed to thus storing the beets, even when paid 30c per ton for so doing, but experience in '95 and '96 convinces them that it is an advantage to the grower also because it gives him a longer time in which to deliver the crop. Concerning the way in which beets keep in these silos, Mr Wietzer of the Norfolk factory writes us:

"Regarding loss in actual sugar of beets kept in silos, we have no actual results, but we have found that beets lose very little or nothing of their saccharine matter within the first two months after siloing. In the old country, it is no secret that beets lose at least 1 to 1½ per cent of saccharine matter during a three months' time in silo, mostly in cases when weather is warm. Experiments made within the last few years have, however, shown that beets raised without fertilizer lose comparatively very little in silos, while beets raised with nitrate of soda show the greatest loss."

Summarizing the most recent European experience on this point Ware says: "It has been demonstrated that the loss of sugar in silos is due to elevation of temperature and too much ventilation, the greatest loss of sugar always corresponding to the most active respiration of the plant. From this the conclusion might be drawn that by keeping air out entirely the problem could be solved; but decomposition of the roots then would certainly follow. When ventilation is too active, considerable loss

of moisture is the consequence; and when this is excessively low the protoplasms die, followed by alteration in the beet cells. The most desirable temperature for silos appears to be 35.6 degrees to 41 degrees F. Avoid all bruises of roots to be kept. is a maxim never to be lost sight of in beets that are to be stored. Twist off the leaves, but do not attempt topping." We may add that Nebraska experience is



BEET HARVESTER WITH TOPPING ARRANGEMENT.

This Nebraska invention failed in practice so far as topping the beets is concerned. No machine, in Europe or America, has yet been devised that will loosen the beets, lift them from the soil, top them properly, and deliver them at side of row ready for factory or silo. The attempt illustrated above should pave the way to some one's success in perfecting such a machine.

against the hint in the last sentence, as two handlings of the beets cost more than the loss in sugar due to absence of top or necks on beets in silo.

The system of drying beets has been tried on a small scale in California. In that extremely dry and warm climate, the fresh beets when sliced shrink to one-fourth their original weight by loss of water in from three to four weeks' exposure to air and sun. These topped beets contain from 50 to 65 per cent of sugar and can of course be shipped by rail any reasonable distance. The process has only been tried on a small scale and great care had to be exercised to keep the beet chips from fermenting and

spoiling entirely. Whether this can be guarded against sufficiently to make the drying process practical remains to be seen. Should it prove to be feasible, it is possible that such evaporated or desiccated beets might be kept to supply the factories when their original stock of beets was exhausted. In the absence of larger tests of this necessity, it is useless to speculate about it, and the expense of cutting and drying the beets seems to be an almost insurmountable obstacle.

FEEDING AND STORING BEET PULP, TOPS AND MOLASSES.

The pulp from the beets after the sugar is extracted, makes an admirable feed for all stock—horses, cattle, sheep, swine and poultry. Yet its value for this purpose is only beginning to be appreciated in this country, though in Europe the farmers would no more think of allowing beet pulp to go to waste than our farmers would think of curing hay for fuel. At the Utah factory, a feeding company has contracted for all the pulp for a series of years, and have erected adjacent to the factory (so as to save all hauling and handling possible) a complete system of sheds and feeding pens. Two thousand head of cattle are fattened here each season for market. They eat the pulp greedily, consuming from 100 to 125 lbs per head each day, besides about 15 lbs of hay. These cattle command a very good market, the meat being very juicy and tender. The cattle fatten quickly under proper conditions and as the company gets the pomace or pulp for nothing, except the cost of removing it from the factory, the enterprise is a profitable one. The past season over 1000 sheep were fattened here on pulp. At Watsonville, 1700 cattle were fed at the creamery silo, and beets that fall from the wagons there are also used as stock feed, whereas it was formerly necessary to dump the pulp in the ocean to get rid of it. Dairymen pay 15c per ton for having the pulp loaded on cars at factory, and 50c to $1 per ton freight, so that it costs them 75c to $1.15 per ton, besides hauling from local depot to farm; at these terms, they consider it the cheapest and best feed.

The feeding value of beet pomace depends mainly upon the quantities of protein (nitrogenous matter), sugar, starch, fiber and fat it contains, and upon the proportion of these ingredients that are digestible. The California experiment station's analysis of beet pulp may be compared as follows with ensilage of corn fodder and green clover:

TOTAL ELEMENTS OF ANIMAL FOOD IN 100 LBS.

	Beet pulp	Clover silage	Corn silage
Water, lbs,	90.0	72.0	70.6
Ash, lbs,	0.3	2.6	2.6
Protein, lbs,	1.5	4.2	2.7
Fat or oil,	0.4	1.2	0.7
Fiber, lbs,	3.1	8.4	9.7
Sugar, starch, etc,	4.7	11.6	13.7
Total,	100.0	100.0	100.0

AMOUNT OF FOOD DIGESTIBLE ELEMENTS IN 100 LBS.

	Beet pulp	Clover silage	Corn silage
Protein, lbs, 2c,	1.3	2.0	1.4
Fat or oil, lbs, 2c,	0.4	1.0	0.6
Fiber, lbs, 1c,	2.5	4.4	6.5
Sugar, starch, etc, 1c,	4.2	9.2	5.6
Feeding value per ton*,	$2.02	$3.92	$3.22

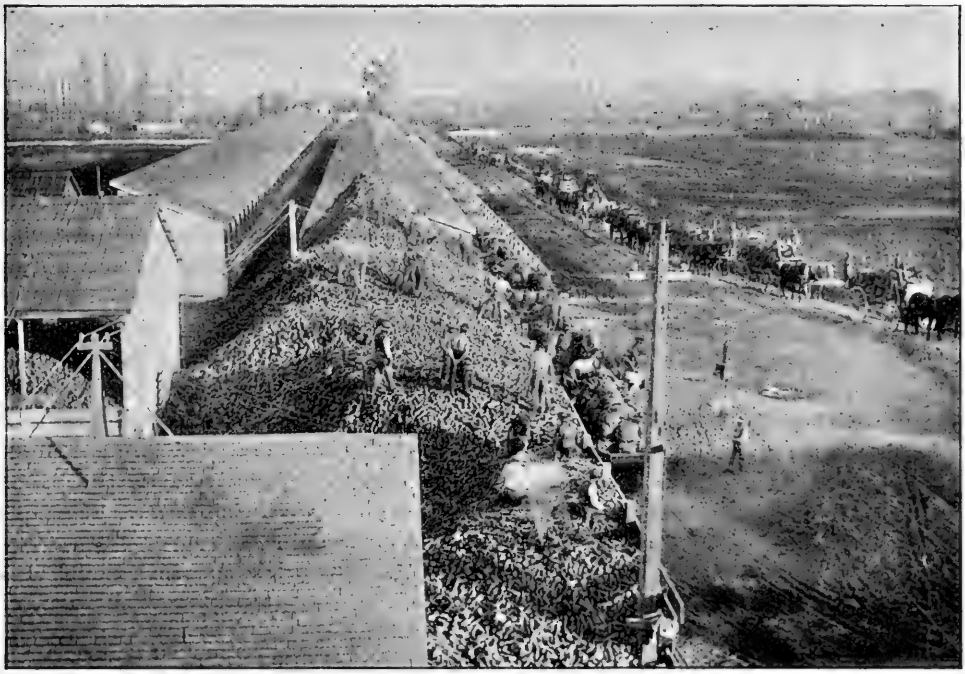
*Based on 2c per lb for digestible protein and fat and 1c for the other nutrients, on which basis the theoretical feeding value of wheat grain figures $17.50 per ton, corn meal $17, potatoes $3, beets 74c, mangels $1.52, turnips $2.75, rutabagas $12 and carrots $1.82 per ton.

The protein contains 16 % of actual nitrogen, and the ash is rich in potash and phosphoric acid, as also lime and magnesia. These ingredients are got back in the solid and liquid manure of the stock that consumes the pulp, so that it has an important manurial value. Indeed, in this way, one can return to the soil much that the crop took from it.

It appears that beet pomace that is nine-tenths water is yet worth for stock feed fully half as much as corn silage only 70 per cent water. If the water was dried out

of the pulp so it contains only as much as the corn silage, it would be of about equal feeding value, pound for pound. But cattle eat only 30 to 50 lbs daily per head of silage, whereas they will consume fully twice as many pounds of beet pulp, and thus get much more actual nutriment out of the pomace than they do from silage, as both are commonly fed.

For milch cows beet pulp is excellent, though it should not be fed to excess. Careful tests at the Iowa experiment station show that the sugar beet is very palatable and contains no volatile acid injurious to butter. But whether milk is sold or butter made, we would not advise feeding beet pomace alone any more than silage



RECEIVING BEETS AT ALVARADO.

Showing outside of sheds and pile containing several thousand tons of beets. Observe the long line of teams ready to discharge their loads of beets.

alone; feed also hay or some dry fodder, with cottonseed or linseed meal, pea meal, or bran. Always begin feeding the pulp to milch cows in small quantities, say 5 or 10 lbs at a meal, gradually increasing as the cows get used to it.

Another advantage of beet pulp as feed is that it can be kept for months without loss of quality by storing in silos. Says Prof Jaffa of the California experiment station: "Sugar-beet pulp is one of the best adaptable materials for silage that the feeder can procure. One of the difficulties encountered in siloing is the exclusion of air from the mass during the curing process. With corn, clover or any of the fodders used for this purpose, much trouble is at times experienced in properly firming the different layers as they are placed in the silo, in order to leave no air spaces in the

mass. The reason for this is, that if much air is present, fermentation will be carried on to such an extent as to spoil a considerable portion of the food. In the case of beet pulp, we do not have to contend with any of the inconveniences just noted. The pulp as it comes from the diffuser in the sugar factory is in the best possible condition for siloing. It is wet, the pieces are exceedingly small and the mass is quite homogeneous. Hence, when placed in the silo it packs itself and fills up every available space, without any intervention on the part of the fillers—a behavior that is very different from that of any other food. For this feedstuff, then, a shallow rectangular or square silo would answer the purpose equally as well as a deep, round one—the style found to yield the best results when corn or clover is siloed. The deeper the silo the greater the pressure, and, therefore, the less air remaining in the silo; the circular shape is adopted so as to do away with corners. It is thus obvious that the expense attending the construction of the silo for beet pulp would be much less than where other fodders are used. In regard to the covering of the material while siloing, the beet pulp has the advantage over corn and clover in that it covers itself, forming a seal, which thoroughly excludes the air. Another point which must not be lost sight of is, that when the beet pulp silage is fed, the portions can be removed much easier and with more facility than is the case where we are dealing with corn, etc. Wherever beet pulp silage has been tried it has met with the best of success, as the animals greatly relish it."

The beet tops and waste beets comprise a considerable tonnage where several acres of beets are raised. This material is also excellent for all stocks, imparting a rare flavor and color to beef or pork, beside making rapid gains in live weight. Feeders about Watsonville are especially enthusiastic over the feeding value of this beet top waste for hogs as well as cattle and milch cows. Similar reports come from Utah and Nebraska, thus fully confirming European experience. These tops will not keep so long as the pulp will, and the sooner they are consumed the better. The tops (leaves), with the neck or upper part of beet that is cut off, constitute about 15 or 20 per cent at least of the gross weight of the crop, so that a yield of 15 gross tons per acre would give about twelve tons of dressed beets and three tons of tops. Many European feeders consider this fodder worth as much as the best hay, pound for pound.

Mr Ware says in a recent issue of *The Sugar Beet*, speaking of Germany: "A factory working 40,000 tons of beets per campaign has 22,000 tons of residuum pulp which, when dried, weighs 2750 tons, the cost of drying being $5 per ton, or a total of $13,750. The product found a ready sale for $17,200, leaving a profit of $3450. Owing to the low market price of molasses, this residuum was mixed with the cossettes during their drying. One hundred pounds of fresh cossettes can absorb 6 lbs of molasses, the product after drying weighing only 15 to 18 lbs. The money value of beet tops and leaves has been determined by analyzing them, and allowing that carbohydrates have a recognized market value. According to all calculations made they should not be sold for less than $1.60 per ton when considered collectively."

The molasses residue from beet-sugar factories has not been much fed in this country. In Europe, however, it has been generally used for this purpose, about one-fourth of the product of many German factories being fed. The great difficulty has

BEET STORAGE SHEDS AT THE UTAH SUGAR COMPANY'S FACTORY.—SEE PAGE 104.

been to find a proper fodder with which to mix the molasses in order to counteract the purging effect which molasses alone (or in conjunction with some other feeding stuffs) exercises on cattle when fed with it, even in small quantities. The latter difficulty has apparently been met by mixing the molasses with a dust or mull obtained from the moss turf that grows on peat. This moss turf is obtained by being torn up or teased out by a machine for making moss litter called a "Wolf." It is taken from the upper strata of high-lying peat moors, and consists largely of the dried but non-decomposed fiber of the plants *Sphagnum cuspidatum* and *Eriophorum latifolium*. The acids contained in this moss turf seem to neutralize the salts in the molasses and render them harmless, thus counteracting the severe purging caused by molasses alone. It is not claimed that this peat stuff itself has any direct feeding value, its usefulness being confined to neutralizing the laxity of the molasses. About 35 lbs of this stuff is used with 65 lbs of molasses, though the proportions vary, and there are several patent processes. The stuff has to be mixed with the molasses while hot. It is being largely fed in Germany, where great claims are made for it, though some feeders dispute these assertions. It is claimed to be much cheaper than the best fat-producing foods, keeps the animal in health, is a good substitute for bran, gives a glossy appearance to the skin, improves quality and quantity of milk, increases weight and improves flavor of meat and can be stored an unlimited time.

The average American farmer will not use any such material. He can, however, mix molasses with cut straw or hay. German experience indicates that the use of molasses in this way increases the amount of actual food elements in the fodder that are digested. The straw is cut into short chaff and the molasses poured over it, which is first thinned a little with water. To every 100 lbs of chaff, add 20 lbs of molasses. Feed with 15 lbs of cottonseed meal or linseed meal or a larger quantity of wheat bran. After cows get used to it they will consume daily 20 lbs per head of this straw chaff with a relish, besides uncut straw and other coarse stuff. The results are most satisfactory. This feed has been found to be most excellent for sheep, hogs, cattle and even horses, but with all stock the feeding with molasses should begin with very small doses. Increase the molasses ration very gradually.

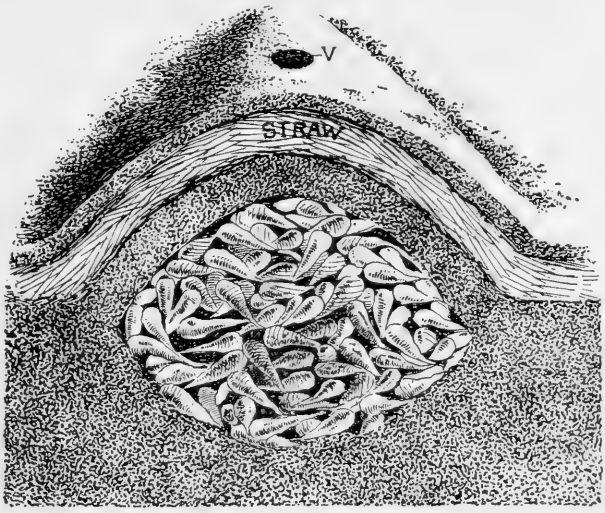
Mr R. M. Allen, who, as manager of the Standard Feeding Co, Nebraska, speaks from long experience in the feeding of beets, necks and tops, says: "I regard it as probable that the profit derived from feeding the waste products of the factory and those parts of the beet left in the field will be almost as great as the profit from the manufacture of sugar. Cattle feeding is a branch of the business that I consider almost as important as sugar manufacture."

PESTS OF THE BEET.

Thus far the most serious obstacles to the production of large quantities of rich beets in the United States have been unfavorable climatic conditions, too much or too little rain or drouth, early frosts, too little sunshine with unseasonable weather during the growing and harvesting period. What can be done to mitigate these natural conditions has been considered in the previous pages. Thus far the crop has not suffered materially from blights or other fungus pests. Beets are sometimes hollow in the center and in that case lack both weight and quality, but this trouble mainly

occurs only in soil deficient in plant food. Improper germination can be avoided by the use of proper seed and the methods of planting already described.

Insect pests have thus far not proved extremely destructive. The garden webworm (*Eurycreon rantalis*) has been perhaps the worst pest. The worm is not quite an inch long, pale or dark yellow, marked with distinctly jet black spots. It feeds on a great many plants, and has several natural enemies. The worm spins for itself a delicate silk cocoon in the debris on the ground at the top of the beet and transforms to the chrysalis stage, in which it remains from one to two weeks. The young worms devour only the surface and substance of the leaf on the side where they are, leaving the veins and opposite epidermis untouched, producing a skeleton leaf. Where the tops are not intended to be fed to stock, Mr Lawrence Bruner, entomologist Nebraska station (Bulletin 16) recommends spraying with a solution of one pound of London purple or Paris green in 200 gallons of water, applied with the modern spraying apparatus, by which the poison is distributed in a very fine mist.



NEBRASKA SILO FOR BEETS.

Cross section. The pile of beets is about 4 feet wide and 3 feet high covered with six inches of soil. Before severe weather sets in, cover with six inches of straw, and then two inches of soil. V—Ventilating holes, one foot in diameter, every 5 feet. See Pages 105-107.

The pale flea beetle (*Systena blanda*), varying from black to nearly yellowish white, gnaws the leaves full of holes upon either side, causing a blister-like appearance, like leaf spot or leaf blight. Spraying with kerosene emulsion drove it away and the arsenical spray effectually removed it. Other flea beetles and blister beetles are sometimes destructive and if necessary can be destroyed as just described. A variety of bugs and a few leaf hoppers are sometimes destructive, the most practical remedy for them being to destroy their natural food plant.

The various cutworms sometimes do much damage by eating off the small beet plants in May and June, in Nebraska. All of these cutworms have parasites that usually keep them from breeding very rapidly, except when some unusually favorable conditions of soil or climate occur. The very best remedy that has thus far been suggested and tried against cutworms is the use of poisoned grasses, cabbage leaves, or clover. This is done by taking these substances and tying them into loose bunches and then sprinkling them with a solution of Paris green or London purple, say a tablespoonful to a bucket of water. Then in the evening scatter these poisoned baits over the field between the rows of beets, cabbage, etc. The worms will be attracted

to them, eat and die. These baits should be renewed several times at intervals of two to four days, according to the state of the weather and the abundance of the worms.

BEET SEED PRODUCTION IN THE UNITED STATES.

At least twenty pounds of seed per acre are required for planting sugar beets. At 12 to 20 cents per lb, this represents an investment of $2 to $4 per acre for seed alone. When from 3000 to 20,000 acres of land are planted to beets for each factory, according to its size, it will be seen that this beet-seed question is a most important one. Up to the present time the bulk of the beet seed used in America has been imported from Germany and France.

Experiments at the department of agriculture's sugar beet station at Schuyler, Neb, with later work by H. H. Nicholson at the Nebraska state experiment station, and the experience of our western beet growers, warrant the conclusion that America can produce its own beet seed. The Utah Sugar Co has 57 tons of mother beets laid by for planting for seed purposes early this spring, a sample of this lot being illustrated on Page 32. They are packed in dry sand and kept at a low temperature to prevent sprouting. These people are now raising quite a large amount of their own seed, have met with great success, and expect by 1898 to cease importing beet seed into Utah. Of course it is very necessary for those who are experimenting in raising beet seed to try small quantities of every variety that comes to their notice. Nicholson truly says that "We cannot build up a great sugar industry, stable and independent, until we have all its absolute requirements in and on our own home soil. We must be free from all possible danger of having our seed supply tampered with, and we must develop varieties of beets adapted to our soil and climatic conditions." Prof Nicholson considered this matter quite fully in his address to the Nebraska beet sugar association, November, '97, from which we quote the following:

The serious difficulty and the great danger—danger to the industry as a whole—in attempting to grow and use our own seed, lies in the lack of proper, I may be pardoned for saying the lack of scientific, selection of parent beets. In this question, of the selection of mothers, is the key to the whole situation. It is a purely scientific question—a question that has been reduced to an exact science by the great breeders and seed growers of France and Germany. If we would not meet disaster, we should sit at their feet and patiently learn the details of procedure.

If, for example, we select this year our best beets—those that will average 16 per cent in sugar—for seed, we will undoubtedly obtain very satisfactory results when this seed is planted. By continuing this process year after year we will soon have difficulty in finding 16 per cent beets—the average sugar content and purity will begin to drop, in accordance with a natural law that all animal and plant life, especially those cases where special features have been artificially developed, tend to return to lower forms.

To keep our beets up to a high grade, then, we must keep introducing props and supports in the way of careful selection in regard to specific points. This introduces into seed growing the elements of science and of expense and lifts the business into the position of a specialty, to be followed only by those content to make it a lifework.

It is a question, perhaps, whether there is yet a sufficient demand for seed in this country to justify the specialist or the capitalist, or both, to enter upon the profession

STORING BEETS IN WISCONSIN.—MENOMONEE FALLS FACTORY IN DISTANCE.

These silos are 6 feet wide at bottom; beets are piled in ridges about 2½ feet high, and then covered with 1½ feet of earth shoveled over them from the intervening space. No straw was used; ventilators every 10 feet. In spite of warm weather since the beets were ensiled in October and November, 1896, they came out perfectly in February, losing only 1¼ % of sugar on the average. The beets averaged about 14 % sugar when put in, and 12½ or more when taken out. Nearly 10,000 tons were stored in the silos illustrated, and 8,000 tons by the farmers. The plate is from Bulletin 55, Wisconsin experiment station.

of breeding beets for seed, as that is what it amounts to. Naturally, the business of producing the seed begins under and is fostered by the factory management. It is greatly to the credit of the American manufacturers that they have thus early taken the initial steps. But, as has been indicated, the attendant expense, the necessity for special knowledge, and the extreme care necessary at every step, soon throws the business into the hands of specialists.

As has been intimated, the problem presents two important phases, first to produce seed of a very high grade, and, second, to maintain this grade against a constant tendency to retrogression. The solution of these questions has demanded not only the practical experience and skill of seed men, but all the resources of scientific investigation. For these reasons there has grown up in the sugar-beet-producing regions of Europe a class of professional beet-seed growers. Some of these, as Dippe Brothers, Knauer and Schreiber, in Germany; and Vilmorin, Desprez, and Legras, in France, have made reputations world-wide and have amassed fortunes in the business. Their methods are based on strictly scientific principles. Details of procedure vary according as this or that feature is made more prominent. In no case do these, or other reputable growers, allow seed to go on the market until it has reached a certain standard of excellence through several years of upbreeding.

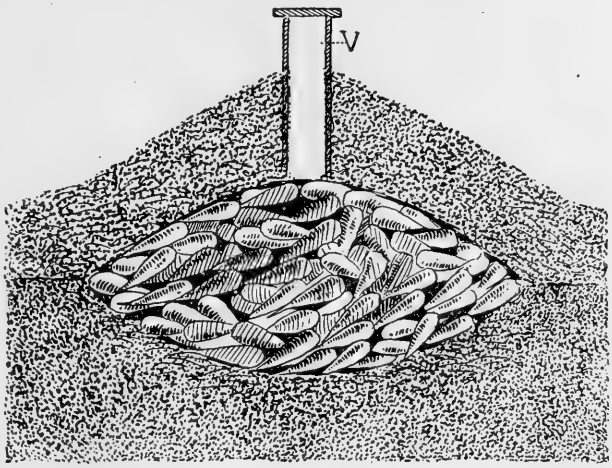
As an example of the extreme care necessary to maintain seed at a high grade, I will briefly outline the ordinary practice of the Dippe Brothers, on their extensive beet farms at Quedlinburg, Prussia. Assuming, for the start, seed of the highest attainable quality. This is planted in the spring in the usual manner and the crop cared for in all respects as a good beet farmer would handle a crop for the factory. In the fall, at the time of harvest, the beets are carefully examined as to their physical characteristics of form, color, size, shape, condition of leaves, and method of growth. Those coming up to a standard previously fixed upon are reserved for seed, while all others go to the factory. This selection usually reserves from one-sixth to one-eighth of the crop as mother beets for the next season. In the early spring of the second year, these mother beets are taken from the silo and subjected to a chemical analysis, for the purpose of securing, for planting, only those of high sugar content and purity.

The analytical process, in brief, consists in taking a small sample from each individual beet in such a manner as to fairly represent the whole beet—this does not in any way injure the root for planting. The juice is then expressed from the sample and polarized. In this way, all of the beets reserved the previous fall are divided into three classes, viz: First, those that fall below a certain minimum per cent of sugar, say 16 per cent, these go to the feed stable; second, those that in sugar content run between 16 per cent and 18 per cent will be planted as seed-producing or mother beets; third, those that run above 18 per cent in sugar will be planted for seed to keep up the stock.

For convenience, we will call these Classes I, II and III, and confine our attention to Class II. When this chemical selection has finally been made, the beets in Class II are planted. In the autumn the seed stalks are cut, the seed thrashed out, cleaned, and put away for the winter. In the following spring—the third from the start—this seed is planted, but in a manner a little different from the ordinary, inas-

much as the rows are closer together and the beets are thinned to a distance of from three to four inches, the object being to produce a very small and rich beet. The usual summer care is given, and in the autumn these very small beets are harvested; another selection on the basis of their physical characteristics is made, and those retained are carefully stored for the winter. In the spring of the fourth year these small and very rich beets are planted for seed production. According to this method, seed to be offered for sale comes on the market in time to be planted during the fifth year after the first steps in its production were taken. This plan, or one similar, is adopted by all successful seed-growing specialists in the old country. Of course, after the first lot is ready for market, each succeeding season furnishes a crop. The only long delay comes in starting.

The questions of expenses and profits can hardly be touched upon in this paper. During the four apparently unproductive years, while he is maturing his first crop of seed, the seed grower is marketing at the factory six-sevenths of his beet crop. With the harvest of the first crop of seed, and thereafter, he will have to sell both a crop of beets and a seed crop.



CROSS SECTION WISCONSIN SILO.

See Page 115 for general view of these silos. The pile of beets is about 6 feet wide and 2½ to 3 feet high, covered with 18 inches of soil, with a (V) ventilating tile every 6 feet that can be closed after the beets have sweated.

Attempts to reduce such propositions to a basis of figures are always hazardous. The main features, in this case, are clear enough that I will venture on some approximations as to the amount of land required and the current operations and expenses during the four years that the first crop is being prepared for market.

Assuming that 80 tons of seed are needed to supply the present demand in this state, and that we are to attempt to supply this with a well-bred native seed, I will follow, in the main, the plan of the German seed growers. We will start the first year with ten acres planted with the best seed attainable. Assuming an average yield of ten tons per acre, we will harvest 100 tons of beets. Making our selection for mother beets will remove from sale about one-seventh, or some fourteen tons. We will have for market, then, 86 tons of beets.

The second year will see the first year's operations repeated in every detail. In addition, we have to make the chemical selection of mother beets for planting, from the 14 tons reserved the previous autumn, and the planting and caring for, say, one acre of seed beets. Assuming now 28,000 beets to be analyzed and selected; two chemists, with proper appliances and assistants, can make 4000 tests per day, or this selecting can be made in seven days at a cost not to exceed $500, including everything

thing except the laboratory and its permanent equipment. In this selection we will retain one-seventh of the beets, giving us 4000 roots, enough to plant one acre—the remaining six-sevenths go for cattle food. We have in operation, then, land as follows: Ten acres sown with seed and one acre planted with mothers.

In the fall the beet crop is harvested, selections made as before for mother beets, and the remainder sent to the factory. Seed is harvested, cleaned, selected, and stored for the next year's use. The books for this season would show a small excess of expenditure over income.

The third year, all operations of the second year are repeated in detail. In addition ten acres of choice land will be sown with seed selected from the previous year's crop, with the object of producing small and very rich beets. In the fall we will harvest a crop of beets for the factory and to furnish mothers for the next year; a crop of seed for further selection, and a crop of small beets of this year's growing. Land in use this year: ten acres sown with original seed; ten acres sown with our own seed of the previous year; one acre planted with mother beets. The books of this year will also show an excess of expenditures over income.

Fourth year; all of the work of the third year is repeated. In addition to this, we plant 100 acres with choice roots from the small and very rich beets grown the previous year. This fall we will harvest beets for the factory and for mothers; seed for further selection; small, rich beets for final seed production, and from 80 to 100 tons of seed ready for the market. Assuming 80 tons of seed, and a price of 15 cents per pound, the seed product of the fourth year would be worth $24,000.

If care has been observed at every step in breeding, this seed ought to be worth, by reason of the higher return it will yield both to the grower and manufacturer, at least five cents per pound more than foreign-grown seed. Each succeeding year now of operation, on the basis and on the scale of these preliminary years, will yield for market from 80 to 100 tons of seed, worth from $24,000 to $40,000.

To actually produce the seed requires, then, the use of not more than 150 acres of land at one time. A proper rotation of crops would demand, for seed growing on the scale thus briefly and imperfectly outlined, not less than 640 acres.

Of course, there will be many difficulties to be met and overcome. In this state, one of these will be the prevalence of winds at certain seasons of the year. It is possible that this trouble may be met by planting rows of corn at intervals among our seed beets, to act as wind breaks. Certain it is that we shall find some way to meet that and similar difficulties.

European beet growers and manufacturers have established careful rules to secure the best quality of seed. They require that the seed must be from the last crop. It must be of such quality that 100 large seeds must furnish 150 sprouts, and 100 small seeds at least 130 sprouts, these should show within 14 days from the beginning of the test. Not more than 20 per cent of lifeless seed will be admitted. Moisture in the seed should never be more than 15 per cent of the total weight, because more of it causes mold, which injures germinating power. There must be about 45 seeds per gram, or about 22,500 per pound for large seed.

CHAPTER IV.

COMMERCIAL ASPECTS OF THE BEET SUGAR INDUSTRY.

COST AND PROFITS OF BEET CULTURE.

Experience affords widely varying data as to the expense of producing beets and the profits of the crop. In unfavorable seasons, or when growers have not learned how to raise the crop most economically, expenses may be comparatively high and the yield inferior in quality and quantity, thus making the cost per ton very high. Mr Leavitt, an extensive Nebraska beet grower, informs us that his first crop cost him $44 per acre to "lay by" until ready to harvest, to which had to be added expenses of digging and delivering to factory, so that even at $5 per ton they yielded but little if any profit on the crop ordinarily obtained. But his sixth successive crop (1896) cost only $11 per acre to lay by, and at $4 per ton the crop yielded a substantial profit. This is probably a greater saving than will occur with the average beet grower, but it illustrates in a striking way the possibilities of economy in beet production. The value of land, expressed either in rent or interest and taxes, and the amount and cost of fertilizers employed, are also varying factors, as well as yield.

We caution farmers and capitalists against basing estimates upon extraordinary yields per acre, either in quantity or quality. While it may be that the crop may occasionally go as high as 20 or 25 tons per acre, and return an apparent profit of $40 to $60 per acre, that is no more a fair criterion to go by than to judge of the possibilities of corn culture on the basis of a yield of 135 bushels of crib-cured shelled corn per acre (which was grown in the *American Agriculturist's* contest in Marlboro county, South Carolina, in 1889), when a fair average yield of corn is 25 bushels per acre. Here is the place for farmers to start right, and not to deceive themselves with fancy figures. Far better for all concerned to go into this industry on so conservative a basis that their estimates are excelled in actual results, than to start with exaggerated ideas, failing to realize which causes discouragement and disaster.

On this point Mr Weitzer, field manager for the Norfolk factory reports: "Our six years' experience in Nebraska has shown us that seven tons of beets per acre pay for all the team work (at 50 cents per hour), all the hand labor (at 7½ to 15 cents per hour) performed on the field, also for seed, rent of land and machinery and freight; all of the yield above this tonnage being clear profit. Ten tons may be regarded as an average crop per acre, although much higher yields are made. A good farmer, who takes the right care of the crop and selects proper land, should, in an average season, raise not less than twelve tons per acre. Our old beet growers even claim to be able to raise, in a good season, by using richly manured bottom land, 25 to 30 tons per acre, which yield has already been obtained by several parties."

Valuable information upon this point is furnished by a tabulated statement of the experiences in 1896 of 49 growers of 1442 acres of beets for the Norfolk and Grand

Island factories, as collected by the Nebraska beet sugar association, and published in its Hastings proceedings for 1896. The area harvested by each grower was from 3 to 80 acres, averaging about 18 acres to each farmer, exclusive of one who raised 455 acres and another with 174 acres. At the time of the Hastings convention, Nov 17, about half these beets had been delivered to the factory, the balance being ensiled for delivery later. The reported yield was 17,924 tons from the 1442 acres, or an average of 12½ tons per acre, ranging from 8 to 20 tons per acre—the larger yields upon the smaller tracts. The proceeds for beets sold were estimated at $90,016, or $62.40 per acre. This was based on $5 per ton for beets, of which $4 was paid by the factory and $1 was claimed under the state bounty offer. If the latter is not paid, the gross proceeds are about $12.50 per acre less, averaging just about an even $50 per acre. The expenses reported average $36.88 per acre, leaving average net profits of $13 per acre, as follows:

	Per acre	For 1442 acres
Cost of seed,	$3.00	$4,363
Rent of land,	3.96	5,708
Value of all labor,	25.56	36,976
Other expenses,	4.36	6,302
Total expenses,	$36.88	$53,349
Profits,	$13.12	$18,751
Total receipts at $4 per ton,	$50.00	$72,100

This shows an average cost of just about $3 per ton of beets delivered to the factory, including wagon haul and railroad freight, on a crop of 12½ tons per acre, over nearly 1500 acres in various sections of Nebraska, and representing all sorts of culture and soil. Closer analysis of the returns shows that the larger yields of the more careful cultivators were produced at a cost of $2 to $2.50, and in one or two instances even less. It is to be regretted that these figures are based on estimates at close of season, not upon actual accounts, though our inquiries indicate that the items of cost are above the actual, if anything.

It is to be remembered, however, that the foregoing figures are for an exceptionally favorable season. They are based upon the experiences of the better growers also—intelligent men, experts, of several years' experience; the other kind, who most need its help, don't attend the beet growers' meetings. Even the best men could not make so good a showing for the unfavorable year of 1895. Yet here are the figures for the '95 crop upon 40 acres grown by Pettinger Brothers at Albion, Boone county, Neb:

EXPENSES.		PROCEEDS.	
Seed for 40 acres,	$107.00	577⅔ tons dressed beets over 12 % sugar 80 purity at $5 per ton of 2000 lbs,	$2888.33
Hand work at $12 per acre,	480.00		
Extra labor,	150.00		
Topping beets at $3 per acre,	120.00	46⅓ tons inferior at $2.50,	115.83
Freight at 80c per ton,	538.40	Received for siloing 258 tons at 30c,	77.34
Total,	$1399.40	Total,	$3081.50

Deducting the expenses reported ($1399.40) from the gross proceeds ($3081.50), there is left $1682.10 as the net return for the team work, use of land, pay for superintendence and profit. This is $42 per acre for these items on a crop that dressed nearly 15 tons per acre, when sold at $5. This price includes the $1 state bounty. Deducting that, or $15 per acre, leaves $27. A detailed statement of Pettinger Brothers' experience is printed on Pages 126-127.

Mr R. M. Allen, president of the Nebraska beet sugar growers' association and of the American sugar growers' society, says that the result of his six years' experience is that "The cost of growing beets to farmers in Nebraska is from a minimum of

$2 per ton delivered at the factory, up to a figure where it becomes unprofitable to raise them even at $5 per ton. The average cost to farmers probably ranges from $2.50 to $3.50, with an average yield of from 10 to 12 tons. These figures do not include rent, fertilizers, or profit. The first two large areas of beets raised under my own charge cost $3.60 and $3.80 per ton, respectively (actual book accounts), the first being a year of very high cost and the second a drouth year of decreased yield." Mr Allen submits detailed statements of these (1893-4) crops as printed below, but we understand his 1896 crop was grown at very much less expense.

RESULT OF CROP.

	1893	1894
Number of fields grown,	21	23
Number of acres grown,	500	569
Lowest yield per acre,	9 tons	6.6 tons
Highest " " "	30 "	19.5 "
Average " " "	17½ "	10 net tons
Net delivered at factory,	15 "	10 " "
Gross tonnage,	8709	6165
Net tonnage shipped,	7514	5803
Shrinkage,	13.43 %	5.8 %
Total cars shipped,	436	346
Average sugar content,	11.94 %	14.95 %
Highest " "	15.50 %	18 %
Average purity,	77 %	79 %
Highest "	86 %	86 %

EXPENSES PER ACRE.

	1893	1894
Cleaning off corn stalks,	$3.50	*a*$2.00
Plowing,	2.20	2.01
Harrowing,	1.30	.50
Rolling,	.50	.31
Seeding,	.40	.30
First hoeing,	4.00	1.44
Thinning,	13.00	5.84
Two times hoeing after thinning,	12.00	*b*12.97
Cultivating,	2.15	1.82
Seed,	2.25	2.00
Cost of laying by,	41.30	30.16
Harvesting,	6.00	*c*6.00
Hauling and loading,	6.75	2.13
Total cost of crop per acre,	$54.05	$38.29
Cost of beets per net ton,	$3.60	$3.82

a Manuring. *b* Second hoeing $5.25, 3d $4.81, 4th $2.91 per acre. *c* Plowing out cost $2 per acre, pulling and topping $4.

In Utah, the average cost of cultivating, harvesting and delivering a crop of 12 tons of beets per acre to the factory, not to exceed four miles distant, is from $28 to $35, and at $4 per ton this leaves a net income of $13 to $20 per acre, besides the $28 or $35 worth of labor furnished by the farmer and his family and teams, for which he gets paid in cash. Going into more detail, the Utah Sugar company says that, if everything is hired or if the labor is charged for at the price it would cost to hire it, the expense of cultivating beets in Utah would be about as follows: "Preparing soil for seed, $3.50 per acre; that is, plowing, harrowing, leveling, rolling and the necessary work to make a proper seed bed. Twenty pounds of seed per acre will cost $3, and planting with the seed drill 50c per acre. Thinning costs about $5 per acre, but this item will be less after a few years' experience. The second hoeing is as necessary as the thinning, and costs $2 per acre. We irrigate two to five times, as the case may be, averaging three times; at 40c per acre for each irrigation, this would cost $1.20, though it may cost more the first season. We cultivate six times, three before irrigation and three after, at a total cost of $14.40. Plowing out the beets in the fall will cost $1 per acre. We pay 50c per ton for pulling and topping the beets, which, for an average yield of 12 tons, is $6 per acre. This makes a total expense of $30.60, exclusive of use of land and manures, paying highest market prices for all labor."

One of the most extraordinary financial statements ever made by an American beet grower is that submitted by James Bardin, of Monterey Co, Cal. In 1892 he shipped 6082 tons of beets to the Watsonville factory from 225 acres of land, making the phenomenal average of 27 tons of dressed beets per acre. The cost of seed and planting averaged $5.12 per acre, harvesting $7.45 per acre, cultivating and weeding

was done by contract by Chinese at $1.65 per ton, while the freight was 75c per ton. This made a total cost per ton of $2.83, and as the beets were sold at $5 per ton at the factory, it left $2.17 per ton for the use of land and net profit. Adding net gains from stock fed on beet tops, Mr Bardin shows an average return of $59.33 per acre for his own time and use of land, or a total profit of $13,352. Mr Bardin says there is just as much money now in raising beets at $4 per ton as there was then at $5, because freight has been reduced 25c per ton, contracts for taking care of crop, hoeing, thinning, topping and loading into wagons have been reduced 65c per ton, and the crop can be handled 10c per ton cheaper now on account of improved machinery, making a total of $1 reduction to offset the decline of $1 in the price.

Mr Bardin writes us that in 1893 and 1895, he was not directly interested in growing sugar beets. In 1894, he planted 450 acres to this crop, but the land was not in good condition and the yield averaged only 13¾ tons per acre dressed weight. Part of the tract was new land that had not been cleaned but one year, and some had been planted to crops which the beet does not follow well. In 1896, he planted 260 acres, which were all harvested before Oct 1 and averaged between 16 and 17 tons per acre for the whole tract. One of these fields of 80 acres, planted the first week in March, yielded 25 tons of dressed beets per acre. Another field of 100 acres was not all planted until the latter part of April, and owing to the extremely dry season made not more than 8 or 9 tons per acre. If the season had been favorable, he believes the whole tract would have averaged 25 tons and is perfectly satisfied with the crop as a profit earner, when sold at $4 per ton.

Mr Bardin's items for planting the 225 acres first mentioned were: Labor $450, seed $180, use of beet drill $22.50, barley fed to teams when planting $10.50, hay fed (at $8 per ton) $200, wear and tear of tools $150, total $1,152.50 for planting. The detailed account for harvesting shows that the expense was $1677. Caring for the crop was contracted for by Chinese at $1.60 per ton, or a total of $10,166; freight at 75c per ton cost $4561, making the grand total for all expenses $17,556. The receipts being $30,908, left the net profit above stated of $13,352. This is an extraordinary result of an extraordinarily favorable season, which even Mr Bardin himself has not since been able to duplicate. Moreover his land is in beets only one season in three years, and his last crop averaged only about one-third as large a crop as the phenomenal results in '92. Even under the most favorable Californian conditions, therefore, it is safe to discount this result fully one-half and we doubt very much if the majority of California beet growers average $30 per acre per year, for use of land, for their ability in running the business and for net profits over and above all other expenses of every kind and nature.

ACTUAL EXPERIENCE OF FARMERS IN RAISING BEETS ON A LARGE AND SMALL SCALE.

Pettinger Brothers of Albion, Boone Co, Nebraska, writing in September, 1896, said: "Nebraska farmers are only just beginning to know a small part of what there is to learn about farming, and especially sugar beet raising. In Boone county, the first sugar-beet crop was planted in 1884. Our first crop contracted for consisted of ten acres. The soil was prepared and the crop planted the best we could with such instructions as were given by the factory, but the soil was a little sandy, and during

June about half the crop was cut off by drifting sand, or buried out of sight; what was saved yielded about six tons to the acre. While this was a very light crop, we felt encouraged to try again. At first we did our own hoeing and thinning, but have since had German-Russians to do this work; they are by far the best and cheapest labor. The following spring, we contracted to put in 40 acres. The soil is a slightly sandy bottom land, just sandy enough to work nicely, with a good clay subsoil. The field planted in '95 had been a timothy meadow for about 12 years previous to plowing for beets. We plowed six or seven inches deep, following in the fall with a subsoil plow, going to the depth of six inches more, stirring the soil thoroughly to the depth of twelve or thirteen inches and harrowing each day's plowing as it was done. For the seed bed, the field was gone over three or four times with a disk harrow, working the top thoroughly; then we took a railroad iron, put on eight horses and went over the ground until it was perfectly smooth. This smoothing iron is illustrated herewith and I like it better than a harrow, as it packs the soil better and makes a splendid, fine, seed bed, without which it is of but little use to plant beets. Preparation of the soil is the main point; you cannot get the seedbed too good. One great thing is not working the top too fine. In this preparation, most of the work can be done with a disk harrow, as it does not crush all of the small clods, thus preventing blowing and cutting off by the fine dirt and sand that is driven over a field that has been so thoroughly worked. Planting was begun May 1 and finished May 25. A little re-planting was done June 10. A good stand has never failed us if the ground is in perfect shape at the time of planting. Planting is but little trouble, the seed being put in from ½ to ¾ of an inch deep and covered with a moist soil. The Jewell planter was used last year with good success. We never use flat shovels in cultivation, preferring the goose-foot shovels, which we like much the best. Thinning is begun when the plants are two inches high. We bunch thin and clean all of the small weeds out at one time and are particular that this work is well done. Cultivation is kept up every week or ten days as long as we can get through them; in all, about five times.

"SMOOTHER" FOR BEET LAND, MADE OF A RAILROAD RAIL.

This leveler is 28 ft long and bent slightly in the middle so that it will not turn over—a curve of say 2 ft in the length of the iron. The horses are hitched far enough from the ends so that the draft of the teams will make the iron plow level. Hitch the horses so that the curve is to the front as portrayed above. If the curve is to the rear, the iron will dip in the middle and the ends draw up and it will not work satisfactorily.

"In 1895 the mode of work was changed but little from that of the preceding year. We were a little more careful as to details. Pains are taken that all weeds are killed before planting. Plant as soon as the soil is ready. Do not let it lay three or four days after it is ready to plant, as the weeds get just that much of a start. We think if we get our crop started right, future cultivation is easy. During the summer of '95, most of our crop was irrigated the latter part of July or early August. Irrigation is what saved our crop from testing low, as they grew and ripened. When the late rains came in the fall, they did not take on a second growth but retained their ripeness and sugar. Out of 56 carloads shipped to the factory, only four loads went below 12 per cent sugar and 80 per cent purity. Last year we did not irrigate, but I believe it will pay as a rule. Our beets were not as good last year as in '95; the early part of the season was too wet. The ground on which the '95 crop was

raised was put to corn, beets and chicory last year; the corn was a good average crop of 50 bu or more per acre, the beets were as good as the average of the field, and the chicory from this field took first premium at the state fair. I believe that 12 tons can be raised every year if the work is done properly. The beet crop of '95 was heavy and it was impossible for the factory to receive and store what beets they could not work up before they would freeze in the ground or in piles, so they gave the farmer about 30c per ton for siloing a portion of their crop and holding it five or six weeks, thus giving the factory a chance to take those siloed beets later in the season. This same crop furnished a splendid feed of beet tops for milch cows, making the entire feed for our 26 head from Oct 1 to Jan 1. They produced an extra flow of milk and it tested high at the creamery. An acre of beet tops is worth from $3 to $5 as feed for cows and hogs, both of which eat them greedily."

Here are some reports from farmers at Chino, Cal, for the seasons of 1891-4 inclusive: E. M. Day planted 25¾ acres to beets, from which he harvested 409 tons, for which he received $1400. On his home place he had 5¾ acres, the beets from which brought $525, or $91.30 per acre. On another ten acres he harvested 204 tons, which brought him $4.50 per ton. This makes the returns for the ten acres $918, or $91.80 per acre. The $1400 he received for his entire crop was all clear gain, except $40 he paid out for wages and $75 for seed and use of cultivator. Himself and two boys, one 11 and the other 15 years of age, did enough work on their own crop and in exchange with their neighbors to clear all expenses on their own crop except the $115 noted. In other words, Mr Day's summer work on his beet crop has brought him just $1284 in clear cash. Besides this, he has taken care of, cut and harvested ten acres of alfalfa of his own, raised fourteen acres of barley, and did $50 worth of work cutting alfalfa and barley for other people. This will go a long way towards paying all his living expenses for the year, and his beet crop can be counted clear gain. Mr Day says he lived in Nebraska for twenty-five years and in all his farming experience he has never done as well as he has here, or found the product that paid as well as sugar beets.

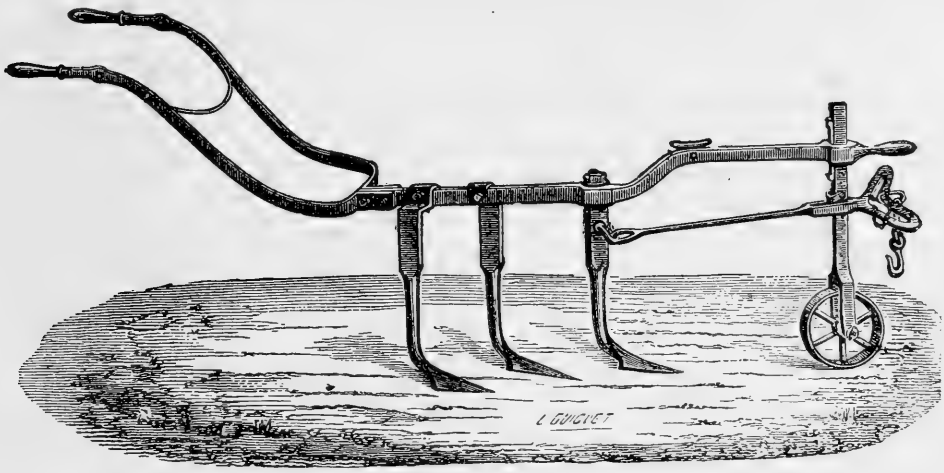
George C. Moore rented 36 acres, which he planted to beets. He did the team work and a large part of the labor upon the crop himself, hiring no more than he could avoid. He is an energetic, painstaking and careful man, and his care has been well rewarded. In making a statement of his expenses on the crop, he included his own labor and that of his teams. His actual expenses in money were therefore much less than the figures given. He sold 649 tons (at $4.25) for $2.758.25; expenses: Plowing $72, preparing ground $27, seed $64, planting $12, thinning $108, cultivating $25.20, hoeing $70, pulling and topping, $374.50, hauling $299.60, factory expenses $52.45, total $1,104.75; rent, 25 per cent, $684.56; grand total, $1,789.31; net profit, $968.94.

Peter Varner harvested from eighteen acres 360 tons of beets, or twenty tons per acre. For these he realized $3.90 per ton, or $1404 for his crop—$78 per acre. Less than three years ago Mr Varner came to Chino with no capital whatever but his energy, his perseverance and his pluck. He has recently purchased $3000 worth of land for a home, and he is paying for it with money realized from beet farming. He

says he is satisfied that there is no other line of farming in California in which he can do as well as growing sugar beets.

N. S. Rice planted sixteen acres, from which he harvested 201 tons net, or about 12¼ tons per acre. At $5.60 per ton, these brought him $816.52, or $51.04 per acre gross. The money he actually paid out in raising and harvesting the crop was as follows: Seed $57, thinning $54, plowing and planting $30, topping $10, total $242. All the rest of the work was done by himself and no account was kept of it. This leaves his returns on the sixteen acres $574.52.

W. C. Rightmier harvested from twenty-seven acres 400 tons, or an average of 15 tons per acre. They analyzed between 13 and 14 per cent sugar, making an average



DELVER FOR WORKING THE SUBSOIL.

Machines of this character are not used in America, but are considered almost indispensable in Europe. The work of the delver begins where the subsoil plow left off, the delver running after it to still more deeply stir the subsoil so that the beets have the least possible resistance to overcome in their descending development. Mr Ware says in *The Sugar Beet* for November, 1896, from which our engraving is taken: "This delving operation is frequently continued even after the roots have attained considerable size, that is, after weeds are little to be dreaded and when the cultivators are no longer necessary." It is easy to see how useful such an implement can become, especially during a long dry spell, when the lower portions of the soil are frequently too hard to admit of a thorough penetration by the shoots and hairy growth of the beet.

price of say $4.10 per ton. This would give Mr Rightmier in the neighborhood of $61.50 per acre from his field. Another field of eight acres gave 172 tons of beets averaging 14¼ per cent sugar, 21½ tons per acre at $4.50 per ton, or a return of $96.75 an acre for the field.

HOW THE INDUSTRY EMPLOYS AND PAYS LABOR.

The chief item in raising sugar beets is labor. It constitutes from 60 to 75 per cent of the total expense of beets delivered to the factory, and in some cases even more. Out of average expenses of $36 per acre in Nebraska, over $25 was for labor. Mr James Bardin's 225 acres that produced such a profit in 1892 (see page 121), was sowed to barley the next year, the crop yielding 3500 lbs per acre and at 65c per cental made a net profit of $12.75 per acre—about one-fifth the profit on sugar beets. He paid for labor on this barley crop $360, while the labor on the beet crop on the

same land the year before cost $10,666. Adding $3500 for payroll to labor at factory during the time required to manufacture the crop into sugar, labor got about $15,000 out of this beet crop. In other words, for every dollar paid for labor on barley, there were paid $41 for labor on beets, so that "for every man who gets a job on a grain crop, 41 persons get a job on beets."

Skilled labor is not required for much of the work of pulling and harvesting, while some of the thinning and weeding can be done by boys and girls. The crop thus furnishes an extremely important home market for a grade of labor that otherwise would hardly be employed at all. Indeed, such labor can be worked to better advantage and more cheaply than Chinese contract labor. James Hopkins, Jr., of Watsonville does not believe in paying $1 per ton of beets for Chinese labor, as his crop last year, worked with white boys and girls, cost him only 75c per ton for labor. Of course boys will be boys, and it is necessary to work in the field with them yourself, but under proper supervision boys and girls will work rapidly and well and are to be preferred to the contract system. If 25 or 30 per cent can be saved by employing boys and girls, it amounts to many thousands of dollars each year.

No other crop is so attractive to the laborer of all ages and grades of skill as the sugar beet. It gives employment not only to the farmer, but to every member of his family, pays them spot cash for this labor and yields a fair profit besides. J. W. Johnson made a study of this point in the Nebraska beet fields in '96 and reports in the *State Journal*: "The net profits of the growers, in one case amounting to $1400 on 80 acres, does not alone measure the importance of the industry. Its value to the community consists chiefly in giving employment to all people who want to work, and to that class who are unskilled and can perform only the simplest kind of labor. Anyone who can handle a hoe or pull weeds can earn money all summer in the beet fields. Anyone who can hold a sharp corn knife in one hand and a beet in the other can top beets and earn $1.25 a day. Any man can load beets into a wagon from the field and can shovel them out of the warehouse at the factory. All this labor is available to those who need labor most. There is $25 worth of cheap labor in every crop of beets produced. A large part of this goes into the pockets of poor people who have no ability to make plans for themselves, or to sustain themselves in any other way except by manual labor of the simplest kind."

PRICE OF BEETS.

The price paid for beets is for the net weight of trimmed and washed beets as delivered at the factory. When beets arrive at the factory, an average 50 pounds is taken from each wagon load, thoroughly washed, examined to see if properly topped, and then weighed again, the loss determining the tare. This tare should not be over 5 per cent, if the beets are properly harvested and prepared. Two systems of paying for beets are in vogue, a straight price and a graded price. The beet grower who gets a straight price per ton knows what each ton will bring beyond question, and knows that he can sell all of his beets that come up to the required standard, which is usually 12 per cent sugar of 80 purity. Beets poor in quality are refused or accepted at a much lower price. On the other hand, if paid according to the amount of sugar in the beet, the careful farmer who grows rich beets will get a better price.

The Spreckels factory at Watsonville and his new mill at Salinas pay a straight price, at present $4 per ton, though before the repeal of the McKinley bill it was $5 per ton. We believe the Alvarado factory has also paid a straight price. At Chino, however, the first five-year contract was based on $3.50 per ton for beets containing 12 per cent of sugar and 25c additional for each additional 3 per cent, and under it farmers received an average of $4.50 per ton. In 1896, contracts were based on $3.25 per ton with an additional 25c per ton for each percentage above 12, which has netted the growers nearly $3.78 per ton. To protect their interests, the growers are well organized and choose their own weigher and chemist and also their own tare man, the expense being about 3c per ton.

In Nebraska, at first $4 per ton was offered for 12 per cent beets of 80 purity, the price being advanced 25c for every additional percentage of sugar, up to $7 for beets containing 20 per cent sugar, but it was afterwards found to be more satisfactory to have an average price for all beets above 12 per cent sugar with 80 purity, and this price was fixed at $5 per ton (including the $1 state bounty). If the beets run below this standard, they are accepted at half price. In Utah, the plan was tried of paying different prices for different qualities of beets, but it proved so unsatisfactory to farmers, that one fixed price of $4.25 was established for all beets containing 11 per cent sugar of 80 purity, the price for 1897 being $4, and beets below this standard are not accepted at all. Where the farmer is careful with his growing crop and at harvest sorts out all the large coarse beets, this crop will usually fulfill the contract.

HOW TO GET A SUGAR FACTORY.

The first step to take to get a beet-sugar factory, is to demonstrate that your township, county and district can grow the right kind of beets in profitable quantity. If your farmers have not demonstrated this fact, apply to your state experiment station for particulars about tests that have been made in other parts by the state. Get all the points you can from your experiment station—that's what it is for, to help your farmers and free of cost to them. Then from the instructions given in this book, let every farmer grow half an acre or less of beets. Have samples of all these beets analyzed at your state experiment station* to determine their sugar content and purity. Keep a record of all these crops, the soils and conditions under which they were grown, yield, cost, etc. Repeat these tests a second and third year if necessary, to establish the fact that your locality is adapted to the crop. A small patch of beets on various soils on each farm is better for testing than a few large areas. The beets can be fed with profit to stock, if no factory is available to which they can be shipped. This sort of preliminary work has been done for years in many parts of California and accounts for the firm position of the industry in that state.

Analyses of beets grown under all sorts of conditions and soils will enable any practical beet-sugar man to decide whether such locality can be depended upon to furnish beets in sufficient quantity and quality to operate a factory successfully. There is no doubt in the least of the reliability of the laboratory or analytical work of our sugar chemists. Consequently, we were surprised to have a gentleman who was supposed to know something about the industry advise localities wanting sugar factories to begin by establishing a small distillery. "With a capital of $30,000, such

* See addresses of experiment stations at bottom of next page.

a plant could work 30 tons of beets per day, using all roots furnished. Every gallon of pure alcohol obtained corresponds to a certain per cent of sugar in the beet. Then, after the farmers had learned how to grow beets, the purchase of beet-sugar machinery could follow." This suggestion is not practical at the present time, if indeed, it ever was. In the first place, analyses will determine the sugar content, and secondly, such a distillery would not pay. The tax on alcohol is too high and it requires a very large amount of grain to give to alcohol from beets the necessary life. Besides, the whisky trust would interfere with the sale of such a product. The thing has been tried with molasses from Grand Island at the Columbia distillery in South Omaha. It was found there was no money in it. Mr Thomas R. Cutler, manager of the Utah sugar company, informs us that he has investigated this matter thoroughly in both American and foreign countries, and has concluded that in the United States it would be unprofitable.

The beets and other essentials satisfactorily provided for, the one vital question becomes: Will farmers contract for a series of years to grow 2500 to 10,000 acres of sugar beets for the factory, depending upon its size, at an average of say $4 per ton delivered at factory, with the full benefit that may come from whatever state or national aid may be extended to the industry? The locality that is able to offer the best guarantee of this kind is the one that (other things being equal) will prove most attractive to any who may be seeking investment in sugar factories.

To conduct all this work to the best advantage, a local organization is desirable. For this purpose let all interested unite in forming a local branch of the American

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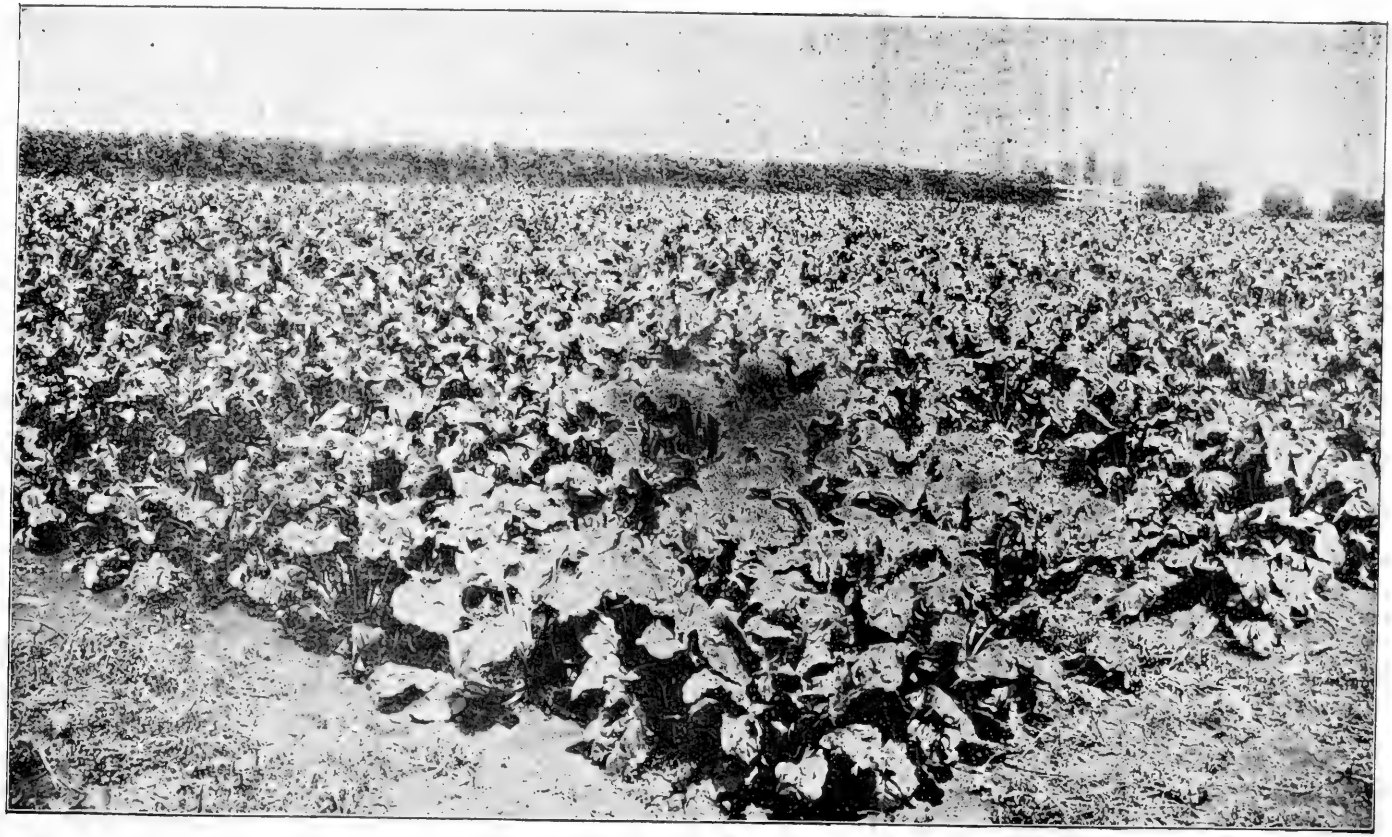
* THE STATE AGRICULTURAL EXPERIMENT STATIONS,

Where located, name and postoffice address of the director or person in charge.

ALABAMA—Auburn: College Station; W. L. Broun. Uniontown: Canebrake Station; H. Benton.
ARIZONA—Tucson: W. S. Devol.
ARKANSAS—Fayetteville; R. L. Bennett.
CALIFORNIA—Berkeley: E. W. Hilgard.
COLORADO—Fort Collins: Alston Ellis.
CONNECTICUT—NewHaven: State station; S. W. Johnson. Storrs: Storrs Station; W. O. Atwater.
DELAWARE—Newark: A. T. Neale.
FLORIDA—Lake City: O. Clute.
GEORGIA—Experiment: R. J. Redding.
IDAHO—Moscow: C. P. Fox.
ILLINOIS—Urbana: E. Davenport.
INDIANA—Lafayette: C. S. Plumb.
IOWA—Ames: James Wilson.
KANSAS—Manhattan: G. T. Fairchild.
KENTUCKY—Lexington: M. A. Scovell.
LOUISIANA—Audubon Park, New Orleans: Sugar Station. Baton Rouge: State Station. Calhoun: North Louisiana Station; W. C. Stubbs
MAINE—Orono: C. D. Woods.
MARYLAND—College Park: R. H. Miller.
MASSACHUSETTS—Amherst: H. H. Goodell.
MICHIGAN—Agricultural College: C. D. Smith.
MINNESOTA—St Anthony Park: W. M. Liggett.
MISSISSIPPI—Agricultural college: S. M. Tracy.
MISSOURI—Columbia: H. J. Waters.
MONTANA—Bozeman: S. M. Emery.
NEBRASKA—Lincoln: G. E. MacLean.
NEVADA—Reno: J. E. Stubbs.
NEW HAMPSHIRE—Durham: C. S. Murkland.
NEW JERSEY—New Brunswick: E. B. Voorhees.
NEW MEXICO—Mesilla Park: C. T. Jordan.
NEW YORK—Geneva: State Station; W. H. Jordan. Ithaca: Cornell University Station; I. P. Roberts.
NORTH CAROLINA—Raleigh: H. B. Battle.
NORTH DAKOTA—Fargo: J. H. Worst.
OHIO—Wooster: C. E. Thorne.
OKLAHOMA—Stillwater: G. E. Morrow.
OREGON—Corvallis: H. B. Miller.
PENNSYLVANIA—State College: H. P. Armsby.
RHODE ISLAND—Kingston: C. O. Flagg.
SOUTH CAROLINA—Clemson College: E. B. Craighead.
SOUTH DAKOTA—Brookings: J. H. Shepard.
TENNESSEE—Knoxville: C. F. Vanderford.
TEXAS—College Station: J. H. Connell.
UTAH—Logan: L. Foster.
VERMONT—Burlington: J. L. Hills.
VIRGINIA—Blacksburg: J. M. McBryde.
WASHINGTON—Pullman: E. A. Bryan.
WEST VIRGINIA—Morgantown: J. A. Myers.
WISCONSIN—Madison: W. A. Henry.
WYOMING—Laramie: F. P. Graves.



BEET TESTS, NEBRASKA EXPERIMENT STATION. (FROM BULLETIN 21.)

Sugar Growers' Society. Then you will be leagued with similar efforts all over the country, provided the society is thus supported, and in many ways can benefit by such connection.

As to financiering a sugar factory enterprise after it is demonstrated that your community can furnish the necessary beets, there are numerous methods. On general principles, we do not favor paying a bonus outright to secure an industry, although this is a very common method. If outside capital is necessary, it can usually be attracted by the offer of the community that wants a factory to furnish a part of the money. Suppose, for instance, it is desired to erect a plant which, with working capital and all appurtenances, requires an investment of $500,000. Instead of offering a bonus of lands or money, let the community offer to take one-fifth or two-fifths or even one-half of the capital stock, provided outsiders will furnish the other half and the expert management the enterprise requires to be successful. Let it be constantly borne in mind that such management is quite as essential as capital. And if the community supplies some of the money, the enterprise will be assured of a more direct interest and heartier support than if it was wholly owned by outsiders. Farmers might take an interest in the factory by agreeing to pay for their shares partly in cash and partly in beets. Except in the very newest regions, where money is extremely scarce, the people in almost any county can raise a goodly sum of money for an investment of this kind if they really mean business. Of course the rights and interests of all the parties to such a trade should be properly seen to, but as a rule we believe in this policy of home talent and home money building up home industries. It fosters a spirit of thrift and enterprise that is often lacking in communities that are supported by industries operated wholly by foreign capital.

If, however, the people of the locality will not put up any money on any of these plans, let them not find fault that they have to depend wholly upon outside capital. Judging from some of the criticism we have heard of the Oxnards' investment in beet-sugar factories in Nebraska, some of the people of that state at least consider it almost a crime for an outsider to invest his money in new industrial enterprises! We can but believe, however, that such critics constitute only a small fraction of the population of that great state. Such critics should understand that other states are only too anxious to attract outside capital, and many towns seem to be ready to make even extravagant efforts to obtain it. But we also feel that some of such enterprising communities would accomplish more in the long run by putting more of their own money into these new industries.

WHERE AND HOW TO START A SUGAR FACTORY.

In starting a sugar factory, it is necessary to erect the plant where there is railroad competition. Transportation of beets and factory supplies is a most important consideration, requiring the lowest possible rates. The sugar itself is also a bulky product, the distribution of which among local and more distant markets must be fairly considered.

The nearer the factory can be to the beets, the better. Unlike other manufacturing enterprises, it should be in the beet fields and not close to a town. If it is possible, the sugar factory should be located in the very center of farming districts, where

at least 10,000 acres of good beet land could be controlled within a radius of not more than six miles, so that the beets can be delivered by wagon. This saves an immense amount of expense in railroad freights. Moreover, the factory cannot get quite as good results from beets grown at a distance as from those close at home that are delivered by wagon with the least delay after harvest.

An abundant supply of pure water is imperative and perfect drainage is absolutely necessary.

Plenty of pure lime rock, containing a very small percentage of silica, is required. Also coal, coke or oil for fuel. All these bulky materials should be available at the least expense for freight as well as first cost.

No factory should be built with a capacity of less than 300 tons of beets per day of 24 hours, and it should be so designed that the capacity can be increased in future at the minimum of expense. The cost of operating such a plant is 25 to 50c per ton of beet worked less than for a factory with half this capacity. The limit of size beyond which profitable economies cannot be obtained seems to be about 1000 tons of beets per day, as the latest improved large factory—Salinas mill—is practically three separate outfits of 1000 tons capacity daily, but under one roof.

It has been suggested that branch plants be established for making a crude product to be transported by rail to a central factory, where the process of manufacture and refining might be completed. Such plants for making a crude product would, of course, cost a small sum compared to the hundreds of thousands of dollars required in a large beet-sugar factory. Up to the present time, however, all experience with existing methods is against this proposition. Only the larger factories are able to run to-day in this or other countries, and many small factories in foreign parts have had to close their doors during the past few years of lower prices and increasing competition. To meet these conditions, it is imperative that the factory operate on a large scale and in such a way as to reduce to a minimum the expense per ton of beets or per pound of sugar. It costs relatively but little more for the experts and labor to operate a plant capable of working up 600 tons of beets per day than one of half that capacity. The beet is such a bulky product that every possible means must be taken advantage of to keep down the expense of handling or working it. There are many pretty theories about what might be done, but the average investor or farmer realizes the necessity of sticking close to the latest improved methods that have demonstrated by actual experience to be money makers.

Of course improvements in sugar manufacture are even more likely to be made in the future than in the past. There has been much talk of late of the new process of crystallization in motion, the Seffens process, osmosis and several others, but it costs enormously to introduce them and it is a question to be decided in each case whether the result pays in dollars and cents. American genius may yet solve these and many other problems, including the matter of small factories, refining, etc, but meanwhile, those who are in the business for revenue will let the "other fellow" do the costly experimenting. In order to compete with the sugar trust, our American beet-sugar factories have been equipped with refining outfits and thus realize the refiners' prof-

its. Mr Ware says that in Europe, the tendency is to abandon this plan, the factories making raw sugar to be shipped to refineries.

It is quite possible that the system of branch factories tributary to a central plant, similar to the Cambria factory in France, may at some time be established in the United States. The Cambria central factory is located in the midst of beet fields and is also near limestone quarries and coal mines, and has water transportation for all these raw materials. There are 16 rasping stations, the furthest being nine miles away from the central factory, with which they are connected by pipes at these stations. The beets are washed, weighed, sliced, and run into the diffusion batteries in the way common in American beet-sugar factories. The juice from the diffusion batteries is then treated with a solution of lime to keep it from acidulating and is forced through pipes to the central sugarhouse, where it is at once carried forward in the manufacturing process in the usual way, with certain modifications. This concern works up 3000 tons of beets daily and with its rasping stations gives employment to 2000 men, women and children.

How to build a factory.—All preliminaries having been satisfactorily adjusted and the company ready to build a factory, let it invite bids from the various American firms that make a specialty of this work. The announcements of these experts will be found at the close of this book. They are sufficiently numerous to insure competition and the lowest prices consistent with quality of the machinery required. Some of these concerns can also furnish expert managers to conduct the sugar factory through the first campaign, until others can be educated for the purpose. We cannot too strongly urge our readers to in this way get the benefit of all American experience, as well as competition among factory contractors and outfitters.

COST OF A BEET SUGAR FACTORY.

Kilby Mfg Co's estimate of approximate cost of building a sugarhouse and refinery of a daily (24 hours) capacity of 350 to 400 tons of beets.

Stone work, foundations and floors,	$12,500
Steel and iron, structural frame and roofs,	16,500
Brick work,	12,000
Windows and doors,	650
Hardware,	700
Painting,	800
Tarred paper for roofs,	300
Vitrified pipe,	900
Cornice, cutters and leaders,	300
Lumber,	5,000
Freights on materials,	4,000
Erecting labor of steel and iron frame,	2,000
Beet sheds and storage for beets,	5,000
Pulp silo,	4,000
Complete machinery for refinery,	225,000
Machinery foundations and masonry for boilers,	5,000
Fire clay, fire brick, etc, for boilers, kilns, etc,	4,500
Pipe covering,	2,500
Labor erecting and starting machinery,	20,000
Hardware, belting and other fixtures,	5,000
Freight on machinery,	35,000
Salaries erecting superintendent and necessary help to superintend erecting and starting of sugarhouse and refinery, including traveling and other expenses,	15,000
Total,	$376,650

The Walburn-Swenson Co writes: "The cost of machinery complete for a factory of 300 to 350 tons of beets per day, the whole to be of the very best design and work-

manship and capable of making white sugar direct from the beets, without any refining, would be in the neighborhood of $170,000 on cars in Chicago. The machinery for a factory having double this capacity would cost in the neighborhood of $260,000. The cost of a first-class brick building, including boiler house for the smaller size factory, would be from forty to fifty thousand dollars. This would also include foundations, lime kilns, etc. Just what the cost of the sheds for holding the beets would be, I cannot say, but I am of the opinion that four or five thousand dollars would be sufficient to cover this item. All the castings, etc, for the lime kiln are included in

A BIG PILE OF BEETS AT ALVARADO, CALIFORNIA,

Showing also the sluiceway of running water by which the beets are carried into the factory.

the price of machinery, and the brick work would be easily within the above cost of buildings. A building for the larger plant would probably cost $75,000. There is no doubt but what there is a great misconception as to the cost of a factory of this kind, and many people write us, thinking that with an old building and second-hand boiler and engine that has been used for some other purpose, they have a good nucleus for a beet-sugar factory, and for twenty or thirty thousand dollars it can be all fitted up. Any attempt of this kind is simply throwing money away, and it would be a great misfortune to the beet-sugar business to have it gone into without sufficient capital to erect a factory of proper size, as well as of the most modern

construction. The machinery, of course, comes very high, but it must be built in such a way that there will be no mistake about its working, as breakdowns and delays are fatal to the industry during the short season they have to work."

As competition increases the number of machinery builders and the demand for apparatus of the same kind and dimensions increases, these prices will doubtless be reduced.

ON THE MANAGEMENT OF SUGAR FACTORIES.

A factory having been well located, properly constructed and equipped, its proper management involves three essentials. First, expert or scientific oversight of the processes of sugar manufacture; second, the utmost economy, good management and businesslike methods in conducting the work of manufacture, seeing to it that there is no unnecessary expense or waste, that labor and machinery are constantly employed to the best advantage and that all the operations of manufacture are managed in the best way possible; third, proper financial or business management, in obtaining supplies, selling the product and attending to the manifold and extensive financial operations involved in so large an enterprise.

The thoroughness with which each of these essentials is observed will govern the profits of the enterprise. No one should put money into the business on the supposition that it is a bonanza that can be conducted carelessly or wastefully or in defiance of business principles. Within a few years, the number of sugar factories will be such that, with competition from abroad in the desperate efforts of the foreign sugar industry to throttle American interests, only the best-managed concerns will operate at a satisfactory profit. The fact that a plant can run only about one-third of the year, makes the "dead season" a long one, and also increases the depreciation in machinery. The earnings of the business should be sufficient not only to pay a reasonable dividend upon the capital stock, but also to keep up the plant, and to charge off liberally for depreciation. Unless this is done, after a few years repairs will not only consume all profits but perhaps require additional capital. Even in Germany, many failures have occurred in sugar factories, but in 90 per cent of the cases, bad management was the direct cause.

"Great progress has been made in the actual science of sugar extraction. Not many years since, it was considered highly satisfactory if molasses residuum represented 4 per cent of the total weight of beets worked while now in many factories 1¾ per cent is the least amount that is considered to represent good work in German factories. An improved process of sugar manufacture in Germany is claimed to greatly reduce the bulk of molasses, to only 1.38 per cent of the total weight of beets worked at the factory. In a German factory working under favorable conditions during the past campaign, the beets averaged 12.92 per cent sugar and the extraction was 12.26 per cent, the loss consequently being 0.66 per cent of the weight of the beets. This loss was made up as follows: In the residuum cossettes 0.25, waste water from diffusion 0.12, filter press scums 0.25, second filter scums 0.03, which means a total of 0.65, leaving 0.01 per cent unaccounted for. There was consumed limestone 4.6 per cent weight of the beet, coke 0.69 per cent, fuel 10.2 lbs per lb beets."

Mr Ware also cites a 550-ton factory (in Germany), where the expense of factory operation of $2.03 per ton of beets in 1893 was by closer management reduced to $1.52.

three years later, when it was for fuel 43c, lime and coke 16c, labor and siloing 56c, maintenance and depreciation 15c, sundries 22c.

AS TO CO-OPERATIVE SUGAR FACTORIES.

A great deal of loose talk has been indulged in upon this subject. Farmers and others who would not co-operate or work together to conduct the simplest form of a country store, creamery or co-operative marketing, have proclaimed learnedly as to the advantages of co-operative sugar factories. The ideas expressed have been in the main crude and unbusinesslike, though the object sought is highly commendable.

In this, as in all other co-operative effort, it should be distinctly understood that co-operation is not a new method of conducting business but simply provides a different method of dividing the profits of industry—to labor or produce rather than to capital. "The same principles that govern success in acquiring profit on capital, apply to the acquirement of profit to divide upon labor. Industry, application, perseverance, good judgment, all are required in the co-operative as in the existing methods of industry. Co-operation is not a means whereby the business of production and distribution will run itself and pour a golden stream into the pockets of the people. True co-operative effort is by no means independent of the everyday principles that underlie success in any undertaking or business."

Especially is this true in the beet-sugar business. The factory must be located, built, equipped and managed with the utmost wisdom and in the best possible way. This can only be obtained by employing persons of experience in the industry, preferably those who have had experience under American conditions. These experienced persons must also be reliable, or they may so conduct the enterprise as to use much more money than is absolutely essential. All these points must be properly safeguarded, whether the sugar factory is owned co-operatively, or by a stock company, or by a single individual. In either case, it must be run on the same businesslike basis. Indeed, a factory that is owned co-operatively—that is, by beet growers in part in connection with others—should even be better managed than a private enterprise, because so many are ready to criticise the slightest mistake. Farmers who think a co-operative factory is one that will pay them more per ton for beets of inferior quality than a private factory can afford to pay for rich beets, will be woefully deceived. A factory can get no more out of the business than there is in it.

In a strictly co-operative factory, each shareholder has but one vote, irrespective of the amount of money he has invested. Out of the receipts of the business, the co-operative factory would first pay all expenses, a reasonable sum for depreciation and reserve, a fair rate of interest on capital, and the balance would be divided pro rata on the beets furnished, just as the co-operative creamery pays for butter. If the season is good, the beets rich in sugar, and the markets favorable, under good management such a co-operative factory might possibly pay more than one conducted by the ordinary system, but under unfavorable conditions, the loss would come upon the beet grower for the co-operative factory, as against the stockholder in the capitalistic factory. In other words, true co-operation means that the co-operators assume the risk of the *losses* as well as the *profits* of the business.

If farmers are willing to go in with all these points thoroughly understood and on a basis that will insure proper management, then co-operative sugar factories may

be attempted. To embark on so gigantic a scale on any other basis is folly doomed to failure. The whole country is strewn with wrecks of co-operative failures due to failure to appreciate the above facts, and to absence of the co-operative spirit. On the other hand, certain forms of co-operation have been made a great success in the United States. The author's book, How to Co-operate (price 50c in paper, $1 in cloth, from Orange Judd Company), may be consulted for further particulars.

BRILLIANT OPENING FOR CAPITAL.

Providing always that the American market is reserved for the product of American farms and sugar factories, it can be demonstrated by figures based on actual experience that a sugar factory enterprise is a fairly profitable investment, if properly managed from beginning to end. Without such management, even a gold mine will fail to pay.

Detailed estimates of expenses and profits vary so widely with varying conditions that it is useless to attempt to submit any here. Such an investment in a beet-sugar factory, under the above conditions, should be able to pay an annual dividend of six to ten per cent on its capital stock, after making liberal allowance for depreciation and setting aside a reserve for contingencies, maintenance and improvements. This is after the enterprise is well established. The first few years it might not do as well as this. Some failures will occur if any of the well-known essentials to success are neglected.

Under favorable conditions the industry may pay more than this. But take it one year with another, conservative management should readily divide six to ten per cent, besides keeping the property in such shape as to be able to close out the business at any time and return the shareholders one hundred cents on the dollar. To do this, however, the factory must net at least four cents per pound for its sugar and with proper legislation to protect against subsidized foreign competition and to guard the industry so far as possible against monopoly at home, this price may be expected to prevail for some years. The sugar could then be retailed to the consumer at about present prices, and American farmers, laborers and capitalists would put into their pockets the millions upon millions that now go abroad for sugar.

Without such legislation, however, this promise will never be realized. We have seen during the past three years the almost utter ruin of our old established cane-sugar industry, simply because the American market has been open to free sugar from Hawaii and to bounty-fed sugars from Europe. It cannot be too often reiterated that unless the American market is reserved for American sugar, the outlook for our domestic sugar industry, both beet and cane, is indeed poor. But protect the industry in the American market for a few years, and it will then be able to hold its own against the world. Indeed, we shall be surprised if this policy does not make America the greatest sugar-producing nation on earth.

ADVANTAGES OF THE INDUSTRY.

Assuming that the American market is assured for American sugar (unless this is done, we might as well drop the business right here and now), the advantages of the industry may be thus summarized:

To agriculture, it affords a new crop that puts into the farmer's pocket money that would otherwise go out of his community and out of the country; by thus reduc-

ing the area of other crops, it helps all farm values; the beet requires good farming and is an educator in thrift and does not rob the soil.

To labor, the beet-sugar industry offers a new field for employment of both skilled and unskilled labor of all ages, and pays a satisfactory price for it in money that would otherwise go out of the community and out of the country.

To capital, it pays a fair return and under proper management should prove an absolutely safe investment.

To other industries, the beet-sugar business contributes largely. It builds up thriving communities and gives new life to other industries. It is roughly estimated that an investment of upward of three hundred million dollars would be required to build and equip a sufficient number of factories to supply the American market with sugar, which vast sum would be distributed among the mining, manufacturing, building and machinery trades. The annual expenditure for labor and materials, such as coal, lime, coke, bagging, chemicals, oils, etc, would amount to millions of dollars.

To real estate, the beet-sugar industry creates value. Chino ranch lands that are now worth $100 to $200 per acre were hardly salable at $30 to $60 per acre before the factory was located there. Our attention has been called to a fine tract of 30,000 acres of land in California which can be "quietly bought up at $30 per acre and after a factory is successfully established will be worth at least $100 per acre." We consider this a conservative statement.

CROSS-SECTION OF A SUGAR BEET.

A section or cutting down through the middle, showing the alternate rings or cylinders of compact portions and those more translucent, the former containing rather more sugar, and the latter more salts and albuminoids. The lower or smaller part of the beet generally has a larger percentage of sugar than the larger upper part. Illustration reduced from Bulletin 27, United States Department of Agriculture.

SOME CAUTIONS IN THIS INDUSTRY.

No one state has a monopoly of the beet-sugar industry. Some Nebraska farmers have an idea that the business will be confined to their state because it has two factories in successful operation. Such people have only to read this work to be convinced of their error. Moreover, hundreds of enterprising communities are anxious to secure beet-sugar factories, and many of these will doubtless do so.

There are plenty of such communities in a dozen or twenty states where the farmers are not only ready and eager to contract to furnish any reasonable quantity

of beets for a term of years for four or five dollars per ton, but the farmers, business men and others in the community are ready to put up their money to build and equip the sugar factory. So soon as the American market is insured for American sugar many of these embryonic efforts will take on definite proportions.

The idea prevails among some people, however, that sugar factories can be had for the asking. Some of the places embraced in our list of towns that want sugar factories seem to have the idea that to be put "on the list," is all that it is necessary for them to do to secure a factory. Nothing could be further from the truth. It is well to be in this list, so that any interested parties may communicate with you, but if you think you can sit still and have a half-million-dollar sugar factory for the asking, you are very much mistaken. Why? Because, as stated in the preceding paragraph, hundreds of communities that do not believe in the "sitting still policy," are making determined efforts to secure factories.

As a rule, the most difficult thing has been to get the farmers to understand how necessary it is to prepare the soil for the beet crop. If the land is at all hilly, it should be scraped down, as the beet field should be as level as possible. Another difficulty is that the average farmer does not appreciate the necessity of care and thoroughness in every detail with the crop. In raising sugar beets, it is absolutely necessary to get rid of the idea of trying to save necessary labor. The crop cannot be slighted, as can potatoes, corn or small grains.

Another error which farmers in the older beet-growing regions are but just learning to avoid, is to be satisfied with a reasonable tonnage. Too much manure or too much irrigation will produce beets large in size and of great tonnage per acre, but such beets are often late in ripening and usually are inferior in sugar content and purity. It is impossible to extract sugar from beets when the beets do not contain the sugar.

Don't try to utilize old buildings for a sugar factory. A factory, to operate profitably, should be constructed for this special purpose, so as to save every possible item of expense. It might be possible to adapt an old building to sugar-factory purposes and perhaps save a few thousand dollars in first cost, but in nine cases out of ten, this would be "saving at the spigot to waste at the bunghole." The increased expense of operating such a plant, owing to the necessarily inconvenient arrangement of the outfit and work to adapt it to the structure, would rapidly eat up the saving in first cost and thereafter would be a constant extra expense.

Neither is it wise to bother with second-hand machinery or apparatus, unless the same is comparatively modern and strictly adapted to the purpose in view. To conduct either a beet-sugar factory or cane sugarhouse to advantage, the latest, best and most improved outfits only can be employed. This is what your competitors have now or will have, and you cannot expect to compete with them with anything else. If a second-hand outfit is offered you, be sure to get the judgment of a well-qualified expert, like Mr Salich for instance, before doing anything with it. In these days, however, such investments are likely to be unprofitable.

It may be that in the eastern and middle states, where the soil has been better cultivated and fertilizers have been used, that the land requires different treatment than at the west, where the soil has received little culture and no fertilizers. Mr Lap-

ham, speaking from results and experience in Virginia, would in no wise depart from the methods that have been best in Europe.

Beets should never be raised on a large scale by any grower the first year, unless he is willing to spend a large amount of money and does not consider the loss, if any occurs. For the average western farmer it would be advisable not to raise more than three acres the first year, and every beet grower should make it his rule to follow the advice given by the factory as near as possible, and leave his experiments until the second season.

Look out for the promoter or grower who "knows it all." The more experience sensible men have in field or factory, the more they find there is to learn.

One of the greatest needs in the American sugar industry, is for scientific and practical experts to manage the large number of factories required to produce the sugar this country consumes. To supply this need, one or more sugar schools should be established by government in connection with sugar factories. It is by such technical education that Germany has developed the industry so rapidly and successfully.

Another great need is more definite knowledge about the culture of beets. Much can be done at all of our experiment stations. The various states in which this industry is developing should also offer prizes for the best results in beet-sugar culture, to the farmers producing them for factories. The prizes should be governed not only by yield and quality, but by the intelligence and correctness with which an account is given of the methods of culture, expense of production, etc. There is a loud call for accurate data on all these points. This book is an effort to supply this demand, but circumstances in different sections vary so widely that much must be done in each state, and in different parts of each state, to get at exact facts and best practice.

No factory enterprise should expect to make money during its first two years. There is always much educational work to perform of a costly nature, although much of this work has been done by existing factories.

A gentleman who has had long and costly experience in this industry and with sugar factories writes us privately, regarding factory enterprises: "Avoid jumping to conclusions; take plenty of time in studying up the question of where to locate, especially guarding that which is most important,—an abundant supply of raw material; a good supply of water; good fuel, lime rock and coke at a reasonable cost; railroad facilities, and where you are to market the product of your factory, making a long-time contract with your railroads, on sugar out and material in, especially beets. Always select a place where the beets can be grown in the immediate vicinity of the factory, and never attempt to build a poor factory, or any at all, unless you have abundant capital to see you through the first few years, which are always largely experimental. Secure the best possible talent. A cheap superintendent is one of the gravest mistakes. A year can be well spent in investigating before starting such an enterprise. The great thing to be guarded against is, that people who have neither money nor experience in the business will become promoters and that factories will be put up that must fail."

We hope there will be no attempt to overdo this business. The over-booming, over-promoting and over-financiering of railroads and similar schemes in the west

ten and twenty years ago, that did much to bring on the depression from which the country is now happily recovering, should be avoided in this sugar industry. Let us keep the whole thing down to hard pan basis, so that every step taken will be a distinct gain, and the whole industry developed on a substantial, businesslike and permanently successful basis. To this end, the author contributes the present book. He invites correspondence as to every point not sufficiently covered herein, that the deficiency may be made up in a later edition.

COMMUNITIES THAT WANT SUGAR FACTORIES.

Postoffice	*County*	*Name*
	ARIZONA.	
Phoenix	Maricopa	W. S. Devol
	ARKANSAS.	
Olyphant	Jackson	C. E. Frizzell
Fort Smith	Sebastian	H. H. Hoover
Fort Smith	Sebastian	S. A. Williams
Rogers	Benton	H. B. Woodcock
	CALIFORNIA.	
Chino	SanBernardino	Valley Sugar Co
Vacaville	Solano	E. G. Davis
Napa	Napa	C. L. James
Wheatland	Yuba	E. E. Oakley
Chico	Butte	J. McStilson
Salinas	Monterey	James Bardin
Fulton	Sonoma	A. Bannister
Gridley	Butte	L K. Vaugham
	COLORADO.	
Mosca	Costilla	J. R. Patterson
Rhone	Mesa	Henry R. Rhone
Pueblo	Pueblo	Suburban Land & Investment Co
Denver	Arapahoe	Lute Wilcox
La Salle	Weld	R. W. Devinny
	CONNECTICUT.	
Naugatuck	New Haven	F. H. King
	FLORIDA.	
De Funiak Springs	Walton	S. E. Wolf
Ocoee	Orange	T. L. Joyce
Auburndale	Polk	Irving Page
St Cloud	Osceola	Col Allen Thomas
	IDAHO.	
Payette	Canyon	Eugene Autz
Leduc	Blaine	P. Leduc
	ILLINOIS.	
Alma	Marion	W. S. Ross
Monterey	Fulton	D. W. Kelsey
Litchfield	Montgomery	R. S. Nelson
Niota	Hancock	Jacob Zeh
Milford	Iroquois	I. D. Gillum
Mt Carmel	Wabash	W. H. Wildey
Chemung	McHenry	Joseph Kuhby
Forest City	Mason	A. D. Brown
Monmouth	Warren	C. E. Cornell
Ottawa	Lasalle	C. E. Fisher
Kankakee	Kankakee	Leon Hay
Momence	Kankakee	Will Lewis
Chemung	McHenry	Joseph Kuhler
Nekoma	Henry	Robert Lapan

Postoffice	*County*	*Name*
	ILLINOIS (CONTINUED).	
Mulkeytown	Franklin	Scott Clark
Havana	Mason	E. A. Wallace
BuffaloGrove	Lake	J. Weidner & Sons
Polo	Ogle	J. N. Sanborn
Ottawa	Lasalle	I. B. Lovejoy
McHenry	McHenry	J. Van Slyke
Pittsfield	Pike	F. L. Schriver
Jerseyville	Jersey	A. W. Cross
Metropolis City	Massac	A. N. Starkes
Morrison	Whiteside	E. A. Smith
Galesburg	Knox	Robert Chappel
Effingham	Effingham	William Dyke
	INDIANA.	
Fort Wayne	Allen	S. Bash & Co
Bluffton	Wells	L. A. Williams
Wabash	Wabash	S. Haas
Columbia City	Fayette	J. M. Harrison
Monroeville	Allen	W. Dickerson
Aurora	Dearborn	J. Small
Monroeville	Allen	N. R. Spaulding
Blufftown	Wells	W. K. Shoemaker
Logansport	Cass	J. H. Barnhait
Elwood	Madison	W. E. Broyles
Land	Whittey	Lewis Deems
Dana	Vermilion	W. B. Hood
Zionsville	Boone	J. W. Lane
Owensville	Gibson	Levi Skelton
Francesville	Pulaski	W. Benson
New Harmony	Posey	F. Mumford
Morocco	Newton	J. M. Rogers
Fort Wayne	Allen	H. C. Rockhill
Liberty	Montgomery	Ben Snyder
Madison	Jefferson	C. E. Cosby
Evansville	Vanderburg	C. Cordes
Delphi	Carroll	V. L. Ricketts
Newcastle	Henry	A. D. Ogborn
Lowell	Lake	J. Dinwiddie
Columbus	Bartholomew	W. T. Stott
Seymour	Jackson	J. H. Hodapp
Vincennes	Knox	Edward Watson
	IOWA.	
Gr'd Junct'n	Greene	Mrs C. D. Park
Wapello	Louisa	W. S. Kremer
Diagonal	Ringgold	O. B. Overholser
Fontanelle	Adair	F. M. Daugherty
Schaller	Sac	E. W. Bennett
Newell	Buena Vista	J. Jenson
Spencer	Clay	J. C. Winset

Postoffice	*County*	*Name*
	IOWA (CONTINUED).	
Greene	Butler	E. H. Beal
Ames	Story	James Wilson
Dubuque	Dubuque	M. H. Moore
Davenport	Scott	Bus's Men's As'n
Clinton	Clinton	S. M. Highlands
Charles City	Floyd	J. W. Brown
Fort Dodge	Webster	J. B. Butler
Muscatine	Muscatine	W. G. Block
Waterloo	Blackhawk	C. P. Bratnober
Mason City	Cerro Gordo	G. C. Winter
Britt	Hancock	Dr A. J. Cole
Keokuk	Lee	Arthur H. Moody
Casey	Guthrie	G. W. Osgood
Waukon	Allamakee	H. E. Teeple
Primghar	O'Brien	J. H. Wolf
Le Mars	Plymouth	G. E. Richardson
Des Moines	Polk	A. H. Meyer
Sidney	Fremont	J. R. McKee
	KANSAS.	
Humboldt	Allen	J. J. Amos
N'th Wichita	Sedgwick	S. F. Toler
Indep'nd'nce	Montgomery	Mrs A. B. Clark
Topeka	Shawnee	Investment Trust Co
Irving	Marshall	Grant Ewing
Ellinwood	Barton	C. Kattenholm
Oketo	Marshall	C. M. Knight
North Topeka	Shawnee	W. E. Clark
Topeka	Shawnee	F. D. Coburn
Paola	Miami	E. T. Ahrens
Iola	Allen	C. F. Scott
Rosedale	Wyandotte	Henry Senecal
Leoti	Wichita	J. G. Donneil
Salina	Saline	L. A. Will
	KENTUCKY.	
Lexington	Fayette	B. M. Cole
Hopkinsville	Christian	T. E. Elgin
Valley St'n	Jefferson	W. W. Moremen
Morganfield	Union	C. F. Hart
Carrollton	Carroll	O. M. Wood
Warsaw	Gallatin	D. B. Wallace
Hartford	Ohio	S. A. Anderson
Cloverport	Breckinridge	John D. Baggage
Jackson	Breathitt	T. M. Morrow
	LOUISIANA.	
New Iberia	Iberia	J. T. White
Schriever	Terrebonne	J. T. Moore, Jr
Crowley	Acadia	John P. Hoyt
	MAINE.	
Northeast Harbor	Hancock	J. H. Armstrong
Waldoboro	Lincoln	W. H. Levensaler
Saco	York	C. H. Tuxbury
	MASSACHUSETTS.	
Springfield	Hampden	Nathan D. Bill
Shirley Village	Middlesex	B. S. Binney
	MICHIGAN.	
Niles	Berrien	J. T. Barker
Oak	Wayne	J. C. Jackson
New Era	Oceana	J. E. Farnham
Fenton	Genesee	F. A. Bosworth
White Cloud	Newaygo	W. E. Fulkerson
Petoskey	Emmet	A. O. Jenne
Port Huron	St Clair	Cyrus Hovey
Capac	St Clair	S. C. Draper
Mt Pleasant	Isabella	T. P. Collin

Postoffice	*County*	*Name*
	MICHIGAN (CONTINUED).	
Charlotte	Eaton	G. M. Fenn
Cranston	Oceana	E. Morrissey
Port Huron	St Clair	L. B. Rice
Millington	Tuscola	W. J. Haines
Yale	St Clair	J. H. Merrill
Chevington	Sanilac	S. A. Hillman
Dearborn	Wayne	W. H. Manwell
Roseburg	Sanilac	J. Aver
Kalamazoo	Kalamazoo	J. E. Welborn
White Cloud	Newaygo	M. D. Haywood
Benton Harbor	Berrien	F. R. Gilson
Port Huron	St Clair	L. A. Sherman
St Ignace	Mackinac	C. G. Cavanagh
Alpena	Alpena	W. T. Sleator
Mt Pleasant	Isabella	W. E. Preston
Hart	Oceana	J. D. S. Hanson
Lapeer	Lapeer	S. D. Brown
Clare	Clare	L. E. Davy
Detroit	Wayne	Milton Carmichael
Kalkaska	Kalkaska	A. E. Palmer
Grayling	Crawford	R. Hanson
Traverse City	Grand Traverse	Thomas T. Bates
Marshal	Calhoun	W. J. Gregg
Ovid	Clinton	W. H. Faxon
Ashton	Osceola	Wilson Showalter
Pierson	Montcalm	M. H. Holcomb
Northville	Wayne	Morris Lancaster
Mancelona	Antrim	Geo Irwin
Durand	Shawassee	H. D. Soule
Shabbona	Sanilac	David Leslie
Galesburg	Kalamazoo	James H. Wolf
Clinton	Lenawee	A. T. Kishpaugh
Nadeau	Menominee	G. T. Werline
Willis	Washtenow	C. E. Lord
Pigeon	Huron	A. Kleinschmidt
Newaygo	Newaygo	Will Courtright
Gaylord	Otsego	Charles Wyllys
Sault de Sainte Marie	Chippewa	William Chandler
Cheboygan	Cheboygan	E. O. Penney
Saginaw	Saginaw	R. F. Johnson
	MINNESOTA.	
Rush City	Chisago	P. A. Stevens
Faribault	Rice	O. F. Brand
Winona	Winona	Max A. Goltz
Madison	Lac Qui Parle	P. K. Haslernd
Stockton	Winona	J. A. Moore, Sr
Madison.	Lac Qui Parle	J. H. Guenther
Dawson	Lac Qui Parle	A. J. Peterson
Hinckley	Pine	J. J. Folsom
Chaska	Carver	F. E. Du Toit
St James	Watonwan	F. B. Lynch
Winona	Winona	F. L. Randall
Northfield	Rice	John Lawson
Cloquet	Carlton	Fred Vilbert
Winona	Winona	W. E. Walker
Belle Plaine	Scott	Peter Becker
Aitken	Aitken	B. M. Hungerford
Boyd	Lac Qui Parle	E. P. Johnson
Worthington	Nobles	C. M. Crandall
	MISSISSIPPI.	
Natchez	Adams	C. B Brownell
	MISSOURI.	
Marceline	Linn	S. H. Linton
Maltbend	Saline	H. F. Knapp
Bucklin	Linn	R. K. Kinney
West Alton	St Charles	P. A. Edalin
Ballwin	St Louis	E. L. Kern

Postoffice	*County*	*Name*
	MISSOURI (CONTINUED).	
Kirksville	Adair	W. T. Baird
Canton	Lewis	C. W. Barrett
Clinton	Henry	Commercial Club
Montgomery City	Montgomery	Dr C. B. Faulconer
Boonville	Cooper	John M. Humber
	MONTANA.	
Great Falls	Cascade	G. A. Gray
Missoula	Missoula	Verdie Spurgin
	NEBRASKA.	
Indianola	Redwillow	G. B. Smith
Lincoln	Lancaster	M. R. Moret
York	York	L. M. Street
Wakefield	Dixon	S. P. Johnson
Ord	Valley	T. S. Harris
Wayne	Wayne	F. M. Northrop
Dorchester	Saline	Frank Roop
Callaway	Custer	J. Reinhard
Sunflower	Scotts Bluff	C. H. Simmons
Ainsworth	Brown	C. W. Potter
Omaha	Douglas	Sec S Beet Ass'n
Auburn	Nemaha	W. H. Stowell
Wayne	Wayne	F. A. Dearborn
Weeping Water	Cass	A. L. Timblin
Gibbon	Buffalo	C. H. Winchester
Redcloud	Webster	W. L. McMillan
Schuyler	Colfax	J. P. McCullough
Brokenbow	Custer	E. B. Purcell
Neligh	Antelope	E. T. & C. J. Best
Dorp	Logan	Charles W. Parker
	NEW HAMPSHIRE.	
Wolfborough	Carroll	S. Brummitt
	NEW JERSEY.	
Annandale	Hunterdon	M. F. Gand
Hainesburg	Warren	E. O. Ward
Stanton	Hunterdon	Frank Bird
Passaic	Passaic	O. Hepburn
Glen Gardner	Hunterdon	S. F. Bell
High Bridge	Hunterdon	J. H. Exton
Blackwood	Camden	Charles F. Currie
	NEW MEXICO.	
Sante Fe	Santa Fe	S. M. Folsom
Las Cruces	Donen Ana	F. C. Barker
Maxwell City	Colfax	E. S. Warren
Raton	Colfax	Maxwell Land Grant Co.
	NEW YORK.	
McLean	Tompkins	B. L. Robertson
Lansingville	Tompkins	W. J. Emmons
Schodack Landing	Rensselaer	J. W. Knickerbocker
Brainard	Rensselaer	J. D. Tompkins
Bennettsville	Chenango	E. C. Ward
Potsdam	St Lawrence	Harry H. Fay
Earlville	Madison	G. H. Clark
Bondville	Montgomery	L. W. Griswold
Akin	Montgomery	J. K. Mosher
Union	Broome	E. K. Mersereau
Falconer	Chautauqua	M. A. Sealy
Westbury	Cayuga	J. M. Shotwell
Alabama	Genesee	H. J. Williams
Newark	Wayne	P. W. Stuart & Co
W Henrietta	Monroe	W. S. Dunn
Middlebury	Schoharie	W. E. Bassler
Stockton	Chautauqua	P. M. Elmer
Gloversfield	Fulton	W. H. Warren
Port Byron	Cayuga	S. D. Gutchess

Postoffice	*County*	*Name*
	NEW YORK (CONTINUED).	
New York	New York	M. Griffith & Co
Fonda	Montgomery	J. H. Beareroft
Cobleskill	Schoharie	A. B. Borst
E Schuyler	Herkimer	Jno Collins, Jr
Nichols	Tioga	G. A. Ingersoll
Burnt Hills	Saratoga	S. Russell Jones
Evans Mills	Jefferson	Jerome Hibbard
Lyons Falls	Lewis	C. C. Merriam
Fairport	Monroe	J. McMillan
Sterling	Cayuga	J. E. McFadden
North Chili	Monroe	G. A. Osmun
Oswego	Oswego	Byron Worden
Red Hook	Dutchess	J. A. Fraleigh
Phelps	Ontario	W. H. Hicks
Ridgeland	Monroe	Lewis Curtis
Ithaca	Tompkins	I. P. Roberts
Batavia	Genesee	David B. Lent
Morrisville	Madison	John Reidy
Watertown	Jefferson	Ed The Times
Potsdam	St Lawrence	E. J. Eastman
Binghampton	Broome	E. F. Jones
Falconer	Chatauqua	A. D. Warren
Trumasburg	Tompkins	E. A. Hawks
Texas Valley	Cortland	Elehue Sweet
Clinton	Oneida	J. H. Dodge
Collins	Erie	F. J. Quigley
Erin	Chemung	Leon E. Goodrich
Amityville	Suffolk	T. W. C. DePuy
Wells Bridge	Otsego	A. D. Bunch
Poolville	Madison	G. M. Bronson
Yates	Orleans	E. H. Parsons
Binghampton	Broome	I. E. Rogers
Afton	Chenango	Geo B. Burghdorf
Lewis	Essex	R. T. Moran
Brookfield	Madison	M. L. Fisk
East Elma	Erie	Mrs Jas Hopper
Unionsville	Orange	Clevel'd Cider Co
Johnston	Orange	Isaiah Yarmey
	NORTH CAROLINA.	
Sidney	Beaufort	W. N. Archbell
	NORTH DAKOTA.	
Bismarck	Burleigh	J. A. Field
Hawkinson	Richland	R. A. Tyson
Larimore	Grand Forks	T. C. Bruyere
Devils Lake	Ramsey	Wm H. Brown
Mandan	Morton	R. M. Tuttle
Lisbon	Ransom	R. T. Adams
	OHIO.	
Canton	Stark	H. A. Cavnah
Caledonia	Marion	L. J. Russell
Prospect	Marion	E. G. Stockman
Bloomingburg	Fayette	L. Eggleston
Covington	Miami	Z. F. Albaugh
Napoleon	Henry	J. C. Davis
Gr'd Rapids	Wood	J. Huffman
Defiance	Defiance	J. O. Wissler
Dunkirk	Hardin	D. F. Fryer
Chillecothe	Ross	James A. Wood
Mad River	Clark	C. B. Crain
New Philadelphia,	Tuscarawas	S. F. Sweitzer Dr H Troendly
Cleveland	Cayahoga	J. F. Kilby
Hillsboro	Highland	W. G. Richards
Quincy	Logan	J. M. Sullivan
Smithville	Wayne	J. W. Buchanan
Delta	Fulton	Sergeant Bros & Saxton
Wauseon	Fulton	F. H. Kelsey
Herring	Allen	E. L. Lurbin

Postoffice	*County*	*Name*
	OHIO (CONTINUED).	
Urbana	Champaign	J. Harlzter
Coshocton	Coshocton	W. Burns
Danbury	Ottawa	H. Bredbeck
N Bavaria	Henry	J. A. L. Derr
Antwerp	Paulding	W. F. Fleck
Clyde	Sandusky	H. G. Gibbons
Leipsic	Putnam	J. A. Hummon
Pleasant Hill	Miami	Nathan Hill
Brunswick	Medina	Anton Leister
Utica	Licking	W. W. Reynolds
GrandRapids	Wood	Azor Thurston
Granville	Licking	W. H. Williams
Akron	Summit	F. A. Wilcox
Canal Dover	Tuscarawas	J. A. Wagner
Creston	Wayne	J. South
Ravenna	Portage	J. H. Evans
Sandusky	Erie	J. Jarecki, Jr
Crayon	Champaign	B. F. Long
Delta	Fulton	M. S. Sargeant
Upper Sandusky	Wyandot	S. A. Cunea
Paulding	Paulding	J. R. Ross
Medina	Medina	F. H. Leach
Bucyrus	Crawford	Ev'n'g Telegraph
Deshler	Henry	J. C. H. Elder
Flushing	Belmont	James Parks
Jerome	Union	H. Riebel
Middle Branch	Stark	F. E. Immel
Madisonburg	Wayne	B. A. Hoffman
Columbiana	Columbiana	Albert Sample
	OKLAHOMA.	
Pawnee	Pawnee	H. E. Hollingsworth
	OREGON.	
Forest Grove	Washington	A. Buxton
Corvallis	Benton	L. Walker
Newberg	Yamhill	F. A. Morris
Portland	Multnomah	G. W. McCoy
Lebanon	Linn	J. S. Hughes
Myrtle Creek	Douglas	P. T. McGee
Monitor	Marion	J. R. White
Oakland	Douglas	O. G. Estes
Knappa	Clatsop	C. Borglund
Myrtle Creek	Douglas	Henry Trower
	PENNSYLVANIA.	
New Castle	Lawrence	J. A. Thayer
Lancaster	Lancaster	J. Bosler, Jr
Roland	Center	H. R. Curtin
Falls Creek	Clearfield	Amos Goss
Salem	Snyder	C. Miller
Wetona	Bradford	D. Tracy
Prichard	Luzerne	W. W. Prichard
Gregory	Luzerne	R. A. Van Horn
Penns Manor	Bucks	A. R. Ellis
Meadville	Crawford	A. W. Williams
Coplay	Lehigh	D. H. Kline
Littletown	Adams	D. B. Alleman
Butler	Butler	I. McJunkin
New Brighton	Beaver	R. McLaughlin
Lanesboro	Susquehanna	J. A. Taylor
	SOUTH DAKOTA.	
Mitchell	Davison	Frank Weller
Yankton	Yankton	J. W. Hanson
	TENNESSEE.	
Chattanooga	Hamilton	S. W. Divine
Greenfield	Weakley	T. C. Phillips
Nashville	Davidson	Col J. B. Killebrew
	TEXAS.	
Gainesville	Cooke	F. A. Galigher
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Howe	Grayson	Mrs H. Pomeroy
	UTAH.	
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ANNOUNCEMENT.

We learn from reliable sources that The Oxnard Sugar Construction and Development Company is to be incorporated, to devote itself to the developing of the sugar growing and producing industry in this country. The officers of this Company will be:—

HENRY T. OXNARD, President,

JAMES G. HAMILTON, Vice President,

W. BAYARD CUTTING, Treasurer

S. D. Schenck, Secretary,

WILHELM BAUR, Chief Executive Officer and Consulting Engineer.

This Company will have its headquarters in West Virginia, and will commence business, if we are informed correctly, in the early part of May, having a branch office in New York City, at 32 Nassau street. The aim of the Company will be to assist in every way the development of the sugar industry in this country. It will establish various departments, such as an agricultural department, and a construction department. These departments will thoroughly investigate questions of climate and soil and will give directions in growing beets, cane, etc., etc. Testing beets, water, soil and all supplies necessary for the process of sugar making, the investigations will be made by expert agriculturists familiar with the raising of sugar plants in this country. The construction department will propose to undertake the entire building of factories complete in every respect, and will be prepared to guarantee their capacity. This Company expects to be able to undertake the full equipment of a newly built factory with the necessary officers and men, and run the factory, if desired, for the first year.

It will be a headquarters of general information, and will invite consultation on all questions concerning the industry. We congratulate our country, and especially our farmers, on the formation of such a Company, with such broad aims. Their work will be done only by men of high experience and responsibility. The industry of sugar producing is comparatively a new one in this country, and only a few people are familiar with it. Therefore it is one of the best features of the new Company, that they will not only furnish the necessary machinery, seed, etc., but also the experienced men who will assist in planting and producing the sugar.

The names of the officers are a sufficient guarantee of the ability of the Company to do its work. Mr. Oxnard and his brothers have been successfully connected during their lives with the production and manufacture of sugar in this country. Mr. Hamilton has been Secretary of various sugar factories since they have been in existence. Mr. Baur has been twenty years in the sugar business in this country, and is also very familiar with the business abroad. We wish this Company success, and with their success, our farmers' prosperity.

HERBERT MYRICK.

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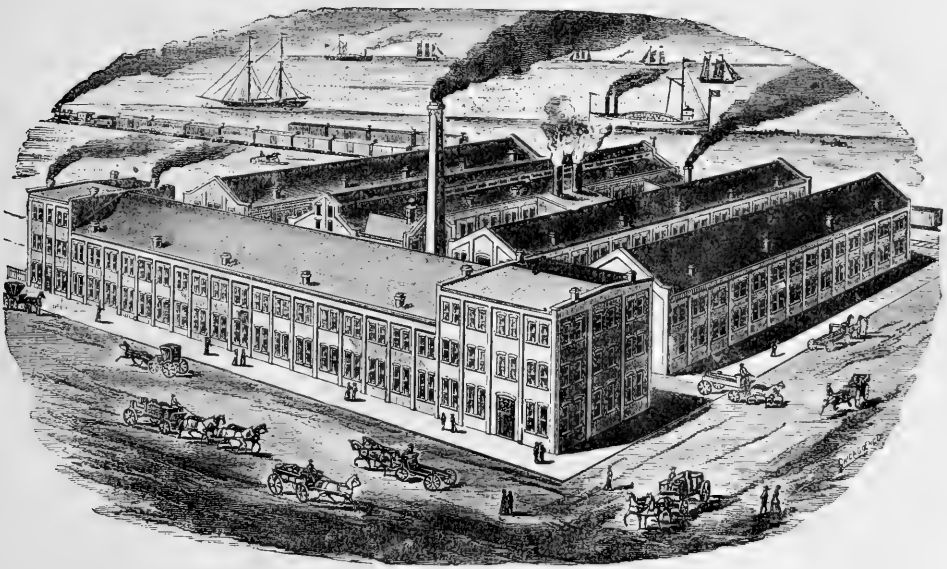

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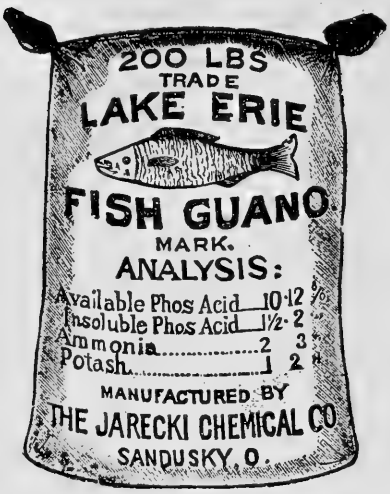

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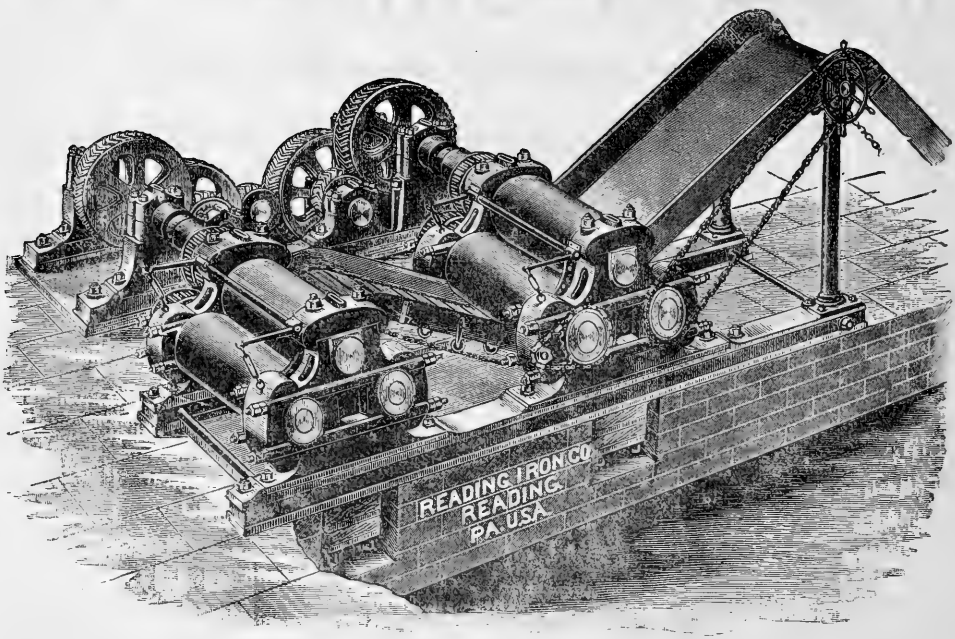

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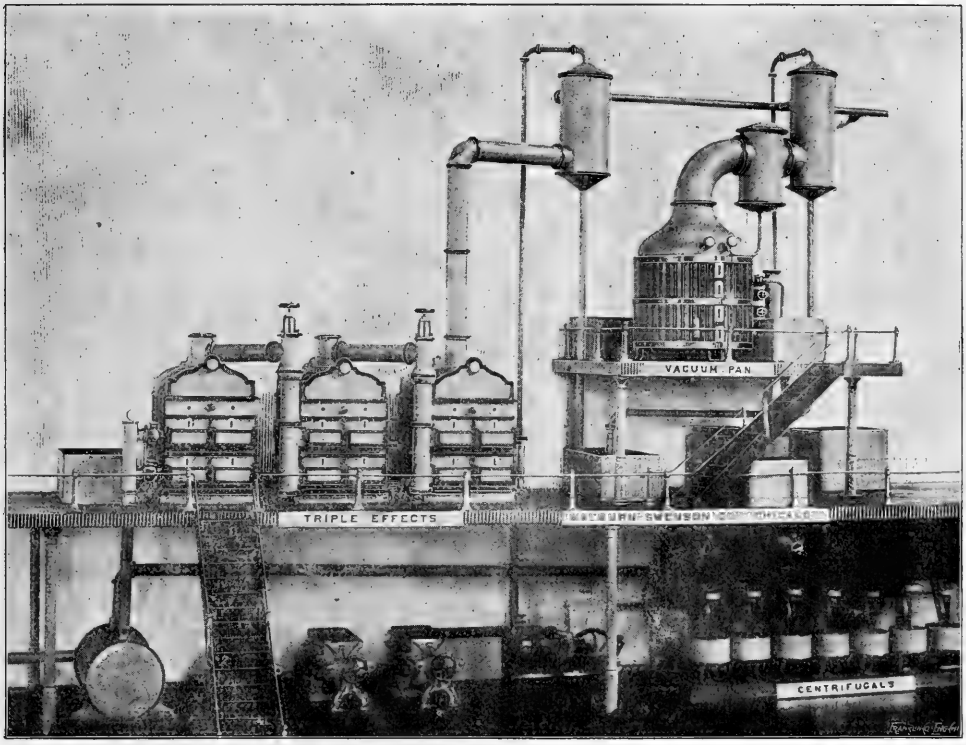

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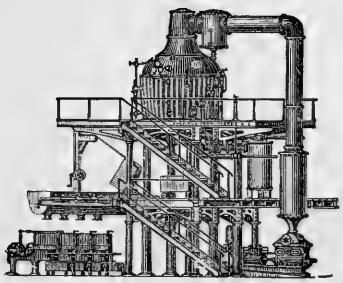

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McCall Bros.,	Teresa,	Flora de Cuba.

Also Brazil, Peru, Sandwich Islands, and every Sugar-Producing Country in the world, and all refineries in the United States, and

Many Plants and Different Apparatus Which are Placed Through Resident Agents or Commission Houses.

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Beet Machinery of Any Description

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R. R. Buildings, Elevators, Washers, Cutters, Diffusion Batteries, Carbonation Tanks and Systems, Filter Presses, Triple Effect, Vacuum Pans, Pumps, Centrifugals, Piping and Boilers. All Parts of a Plant in all Details.

Plant Complete, or in Parts, Designed. Erected and Operated at Lowest Prices, Consistent with Good Workmanship, and Guaranteed in all Particulars.

SUGARHOUSE ON CONSTANCIA PLANTATION AT EUCRUSHADA, CUBA.

In this plant, Mr. Colwell took out some French machinery and replaced it with his own, and remodeled the vacuum pan and triple effect so that the pan would boil in 25 per cent of the time that it did before the change. Mr. Colwell also built on the same plantation the largest pumping engine on the island. The above is a picture of only one of the many plantations for which Mr. Colwell has furnished vast amounts of machinery.

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SOUTHERN CALIFORNIA BEET SUGAR ENTERPRISE

—ON THE—

LOS ALAMITOS RANCHO,

THE HOME OF THE SUGAR BEET.

THE BIXBY LAND COMPANY,

OF LOS ANGELES, CALIFORNIA,

OFFERS FOR SALE

6000 acres of choice sugar beet land and 540 lots in the new town of **"LOS ALAMITOS"**, where a **BEET SUGAR FACTORY,** with a capacity of 700 tons of beets per day, is now being erected at a cost of about $600,000, which will be completed about June 15th, in time to work up this year's crop of beets.

A Few Facts Concerning the Lands, Townsite and Sugar Factory.

LOCATION—The tract is part in the southern portion of Los Angeles County, part in the western portion of Orange County, is distant 20 miles from the **City of Los Angeles,** 14 miles from Santa Ana, the county seat Orange County, 9 miles from Anaheim and Long Beach, a summer resort, 5 miles from the Pacific Ocean.

SOIL—The soil is a rich, deep, moist, alluvial loam, perfectly adapted to the cultivation of a great variety of products without irrigation, most important among which is the sugar beet, which grows rich and luxuriant.

CLIMATE—The climate is mild and invigorating, and owing to the close vicinity of the ocean, is cooler in summer and warmer in winter than locations further inland, being an ideal site for all-year-round homes (the thermometer seldom falls below 35° and rarely exceeds 80°).

WATER—The water for the land and town is obtained from flowing artesian wells, irrigation is, however, not needed here, fruits, grain, and sugar beets requiring no water after being planted, as the subsoil is sufficiently moist to feed the plants.

RAINFALL—The rainy season is from December to April, during which season all the rain of the year falls; there are no long storms, the rain coming in short showers and often at night. Most of the days during the winter are warm, sunny and bright. The average rainfall is about 20 inches.

SCHOOLS—Arrangements are being made now to build and open schools on the tract, and also in the town of Los Alamitos before the fall term of 1897.

TAXES—State and county taxes amount to about 80 cents per acre each year.

TITLE—The title to the land is perfect, and with each conveyance is given a contract to raise sugar beets for the Los Alamitos sugar factory.

PRICE AND TERMS—The price of these lands is from $150 per acre up, according to location. The regular terms are one-fourth cash, the balance on or before one, two or three years, with interest at the rate of 8 per cent. per annum on deferred payments. Tracts can be secured in areas from 5 acres upwards.

A FEW FACTS

And results by some of our farmers who have raised sugar beets in the district and shipped them under contract to the Chino factory, 70 miles distant from the Los Alamitos, show conclusively that the raising of sugar beets is the most remunerative and paying crop for the intelligent and industrious farmer, where in five months from the time of planting he is paid for his crop at prices contracted for before planting, and that three to four crops will pay for the land which is being sold at one-half the price of what similar lands bring in France and Germany, where the beets are not as rich in sugar by 4 to 6 per cent.

RESULTS OF SUGAR BEETS RAISED IN THIS DISTRICT.

	Acres Planted	Total Tonnage	Tons per Acre	Sugar in Beets	Amount Received	Amount per Acre	Expense per Acre	Profit per Acre
H. H. Bartlett.....	2	25	12½	20	$131.25	$65.62		
S. S. Ball.....	4½	71	15¾	18	385.96	71.35	$14.41	$56.94
E. A. Sparks.....	8	110	13¾	20	660.81	70.00	12.48	57.52
I. J. Jones..... ...	40	720	18	16	2851.22	71.25	13.64	57.61
J. W. J. Culton....	25	428	17	16	1829.12	73.16	15.41	57.75
V. Gustavson.. ...	20	343	17½	17	1800.72	90.00	15.53	76.42
G. W. Gamer. . ..	9	223	24¾	18	1208.25	134.25	25.98	118.27

A conservative average tonnage per acre on our lands is 15 and the average sugar in the beets 16 per cent. The price paid for beets by the company is $3.25 for 12 per cent. beets and 25c per ton for each 1 per cent. of sugar additional, thus the average price per ton of beets would be $4.25 per ton.

At 15 tons per acre.....$63.75
Cost of production per acre 20.00

Net per acre at these conservative figures.....$43.75

THE TOWNSITE.

In about the center of the tract is located the new town of Los Alamitos, laid out October, 1896, and the Los Alamitos sugar factory, now nearing completion, which will work up during this year's campaign 40,000 tons of sugar beets and 50,000 tons annually thereafter, for which, including help and other materials used in the manufacture of sugar, the factory will expend each year from $550,000 to $600,000.

The average size of lots in the townsite is 50 x 150 feet.

All the streets are 80 feet wide, the sidewalks 12 feet, the alleys 15 feet.

The purest of artesian water under good pressure is piped in the alley of each lot.

PRICES of town lots range from $75 to $550, according to location. The regular terms are one-third cash, the balance on or before one and two years, with interest at the rate of 8 per cent. per annum on deferred payments.

The government harbor and Southern California's seaport, San Pedro, is but 14 miles distant, and the Southern Pacific Railway, which has built a $5000 depot at Los Alamitos, its present terminus, will connect with San Pedro.

These lands and lots are in the hands of first owners, who are not holding for speculative purposes, but are desirous of having them improved and sugar beets raised on the lands.

Unsold lands are leased to actual prospective buyers at a low rental or upon shares.

Correspondence from those desiring to buy or rent land for the most profitable crop **"Sugar Beet Culture,"** or buy lots in the new and promising town of Los Alamitos, is solicited, and will receive prompt and careful attention. Address

BIXBY LAND COMPANY,

310-12 BYRNE BUILDING,

FRANK J. CAPITAIN,
Secretary.

Los Angeles, California.

The "Sugar Bowl" of the Great Southwest

—IS THE—

RICH VALLEY OF THE RIO PECOS

—IN THE—

COUNTIES OF EDDY AND CHAVES

—OF—

NEW MEXICO.

The seventh Beet Sugar factory in the United States was erected at Eddy, New Mexico, in 1896, and made its first "Campaign" beginning Nov. 15, 1896, and closing Feb. 15, 1897.

The content of "Sugar in the beet" of the crop grown in the Eddy and Roswell sections of the valley has proven to be more uniformly high than in any other part of the United States.

124 separate analyses, chiefly car load lots, showed an average of 17.01 per cent. sugar in beet; 84.1 per cent. purity.

This remarkable result was accomplished by raw farmers unacquainted with the culture of beet root, on new land and under very trying circumstances, as the factory was not assured until May, and a majority of the acreage was planted between June 1st and August 10th.

Fortunately, the land is blessed with just the fertility to produce high grade beets, and,

More fortunately, the Pecos Irrigation and Improvement Co. and the Roswell Land and Water Co. have an irrigation system of great magnitude, covering a vast body of the best sugar beet lands on earth. The water is applied to the crop when needed. The sun shines more hours in the day and more days in the year in Eddy and Chaves Counties, New Mexico, than in any other section of the West.

GOOD SOIL makes the seed germinate.
WATER makes the plant grow.
SUNLIGHT puts the sugar in the beet.

The only thing left to be desired that the Pecos Valley has not on hand in abundance is PEOPLE; we need thrifty farmers—500 heads of families each on a 40-acre farm. No fairer terms or conditions were ever made. Write for particulars.

J. J. HAGERMAN, Pres.
E. O. FAULKNER, Vice Pres.

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Complete Sugar Refineries

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Designers and Engineers of the McCahan Sugar Refinery of Philadelphia—The National Sugar Refinery of Yonkers, N. Y.—Engineers for the installation of all machinery and apparatus in The United States Sugar Refinery, Camden, N. J., and now building complete the Arbuckle Sugar Refinery of Brooklyn, N. Y.

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